Instruments

THE MAGAZINE OF Measurement and Control

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No. 6

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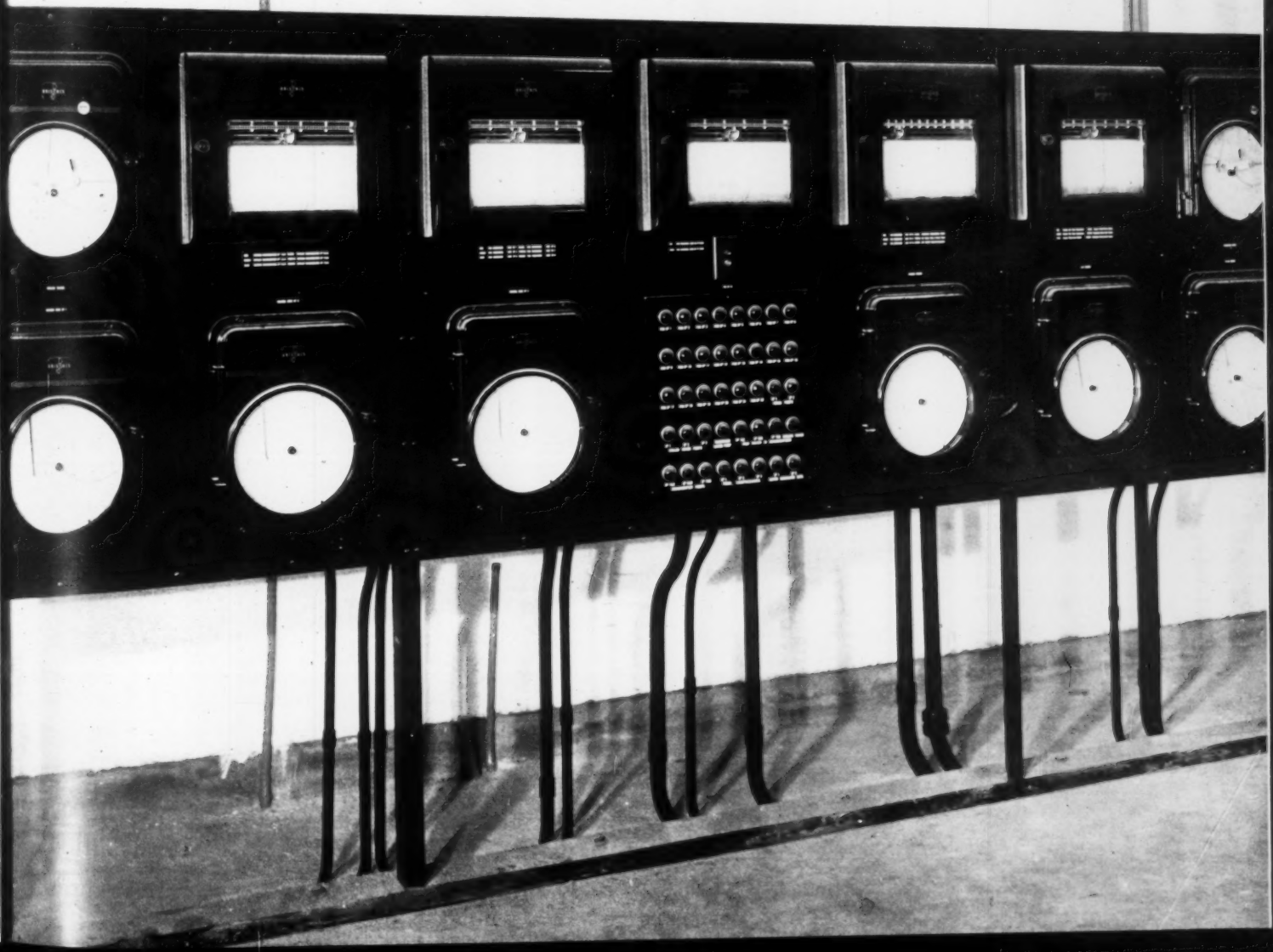
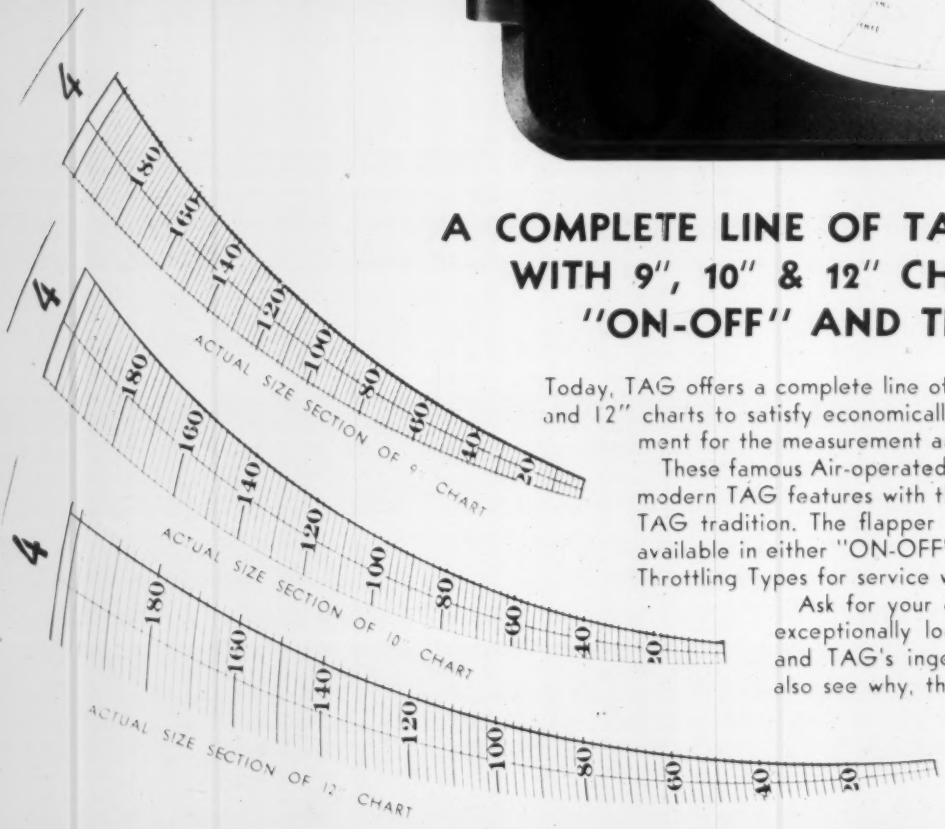


The Service of Temperature Supervision in YOUR Plant!



A COMPLETE LINE OF TAG RECORDER-CONTROLLE WITH 9", 10" & 12" CHARTS AND MODELS FOR "ON-OFF" AND THROTTLING CONTROL!

Today, TAG offers a complete line of modern Recorder-Controllers, using 9", 10" and 12" charts to satisfy economically and with certainty every industrial requirement for the measurement and control of process temperatures.

These famous Air-operated Control Instruments embody all the exclusive modern TAG features with the dependable precision which has become a TAG tradition. The flapper mechanism has been redesigned and is now available in either "ON-OFF" Control Models for most industrial needs or Throttling Types for service where apparatus lag is present.

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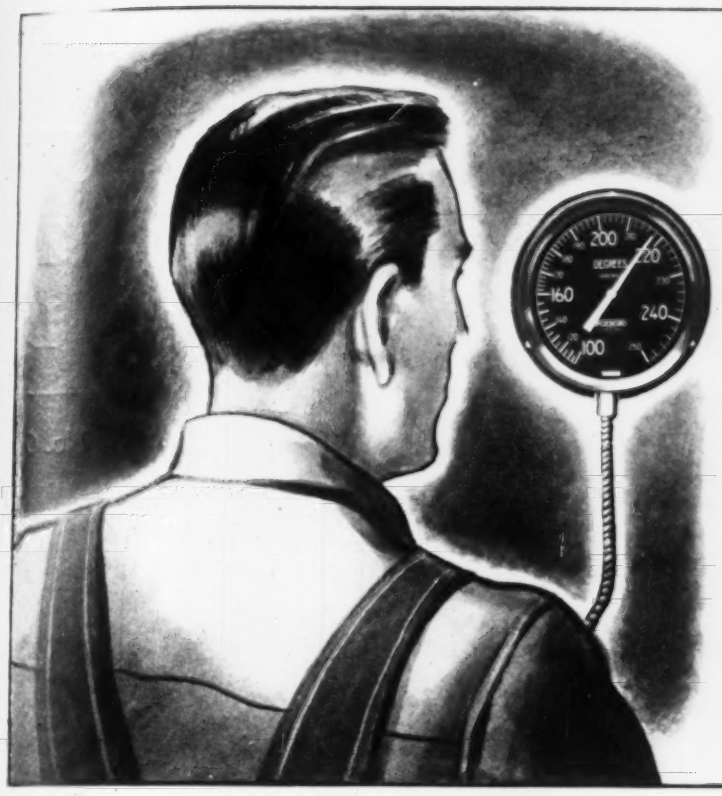

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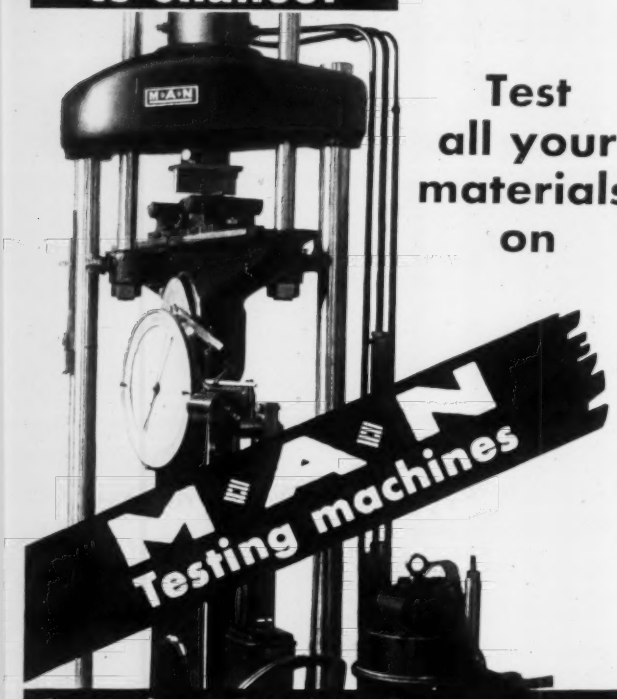

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THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE. LONG ISLAND CITY, N. Y.

Instruments

THE MAGAZINE OF MEASUREMENT and CONTROL

Vol. 12 No. 6

JUNE 1939

FRONT COVER: Air-conditioning control board in Cincinnati's New U. S. Post Office and Courthouse. Courtesy The Bristol Co.

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FLOW OF FLUIDS

A BOOK-LENGTH ARTICLE

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Instruments

THE MAGAZINE OF Measurement and Control

M[illegible] BEHAR, Editor

Dangers From Within

It always is pleasant for a technical magazine to receive letters praising its contents; still more gratifying when correspondents laud its policy. Zealous engineers who derive a living from the professional use of printer's ink take greater pains with the matter than with the manner—and then, afterwards, take greater pride in compliments on the manner! *Instruments* acknowledges with pride the receipt of letters in praise of its May editorial. This was largely a review of two recent books:

Machines Over Men. By RAYMOND F. YATES. Frederick A. Stokes Co., New York, 1939. Gold-embossed cloth, 5½ × 8½ inches, xx + 250 pages, 25 plates. Price $2.50.

Machinery and the American Standard of Living. (Pamphlet No. 81) Machinery and Allied Products Institute, 221 North LaSalle St., Chicago, 1939. Paper, 5½ × 8½ inches, 88 pages. Free.

—an unfavorable review of the first; a favorable review of the second.

In addition to the "fan mail" there came protests. These protests came from Raymond F. Yates, the author of "Machines Over Men." First a telegram, then a quasi-autobiographical letter of about 2500 words, then a reminder. Reportorial accuracy and impartiality would require printing some quotations from the expressions of praise as well as some quotations from the long letter of protest. However, space limitations lead us to give space to the protest only. Another reason is that we admire brilliant spontaneous writing (even when it is directed against us!). Here are the passages from Mr. Yates' letter which we consider the most effective in placing on record his character, politics and attainments:

> That was a heavy and crude touch that you used in connection with MACHINES OVER MEN. I'd make your face terribly red if I told you the name of the internationally-renowned scientist who read and approved this ms. before it was published.
>
> I have published 22 books, been managing editor of *Popular Science*, editor of *Popular Radio* and contributing editor to a number of other publications.
>
> Your crude reference to my political beliefs are distinctly distasteful to one who is as fanatically devoted to the principles of old-fashioned Republicanism as I. It is getting so nowadays that one can not open ones mouth in the expression of an honestly held opinion or a doubt that some upstart does not come along and yell either "fascist" or "red."
>
> As further evidence of my "red" activities, I might mention that I am vice-president and general manager of Kromes-Mumm, Inc., now controlling important patent rights in the field of plated aluminum.
>
> And you the Silver Knight whose duty it is to protect society from "radicals" like me.

As we read Mr. Yates' letter, our face did turn red (not with mortification, for *Instruments* **sees no reason to retract its review of "Machines Over Men"**) but with fear for the future of Technology's progress—a fear based on the realization that the powerful, close-to-the-White-House, prophets of "technological unemployment" who themselves are not technicians, are gradually succeeding in converting to their dangerous beliefs some technically-trained men—not only youths or weaklings, but even some of the older, renowned, successful men who ought to hold fast to the credo that has for its first article "Automatization Makes Jobs."

It is terrifying to realize that the author of "Machines Over Men" has the brilliant record summarized in the above extracts and is, as we learn from his letterhead, "Former Chief Engineer Hudson Engineering Corp., Electrad Corporation of America . . ." etc. We never are afraid of shabby soap-box orators but we have reason to fear the effects of utterances against labor-saving devices by highly-respected and influential citizens, especially those who have won their spurs as engineers. Mr. Yates is undoubtedly the type of man to whom we are drawn, with whom we would enjoy hunting and fishing for days at a time and whom it would honor us to have as a house guest; and that is a reason why we dread his power to influence American public opinion. When we read his letter, one of the first thoughts that came to our mind was that we first had felt this kind of fear in 1934 while reading a book by another successful technical man who, like Mr. Yates, had come to believe that automatic devices create unemployment: the late John L. Hodgson, famous British engineer whose inventions created thousands of new jobs, a man of rare charm and culture, wrote:

> I am haunted by a wan army of 20,000 unemployed from whom my efficiencies have filched away their life purpose and their means of adequate livelihood. It is the job of the efficient engineer to create unemployment.

Last year we had a similar scare when the U. S. government was about to issue the first official Report on Instrumentation: though *written by three technicians* it claimed that instruments throw men out of work. (Fortunately, Uncle Sam had us revise the text before publication.)

For years we have been crusading in favor of automatic devices as job-creators, and urging *Instruments'* readers to combat the propaganda against them. As a rule, our editorials gave the impression that the only sources of danger were outside our ranks. Perhaps this was not the most effective policy. Perhaps we should henceforth recommend a different strategy. On this occasion, therefore, we solemnly declare it to be our considered opinion that a prime duty of all instrument users, who know that Automatization Makes Jobs, is to convey their pride in their work to technically-trained men who are being influenced by the "technological unemployment" propaganda.

In re-reading Mr. Yates' letter to make sure we did him justice, we came across a passage in which he claims that he is not an enemy of the machine. Here it is: "If you want to persist in your Kettering-Ford ideas of Utopia you go right on persisting, but don't call me a red if I don't agree with you. And that does NOT make me an 'enemy' of the machine as you infere." This passage may afford a clue to the line of reasoning followed by some engineers in arriving at conclusions such as those printed in Mr. Yates' book.

With all due respect to Mr. Yates, we maintain that there are only two ways of ending unemployment in the United States: One is to adopt totalitarian slavery; the other way is to produce more in order that all three thirds of the Nation shall be well-housed, well-clothed, well-fed and shall be able to own cars, radios, encyclopaedias, refrigerators and other material aids to modern civilization. Now then, to produce the optimal quantities of goods without enslaving the producers, it obviously is necessary to minimize the labor content of each product, and this can only be done by *gradually extending the areas of automatization*, because every new labor-saving instrument helps cut down the sum total of human drudgery and increase the sum total of leisure and civilization. We are not the Utopians: we are the believers in gradual progress through the natural, unhampered, advance of technology. Those who would hamper this progress are the chasers after rainbows. Some, like Mr. Yates, are good Americans who are not "red" in the political sense, but the majority of those who fear automatic

(Continued on page 166)

THE MONTH'S NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.

When writing to manufacturers directly, please mention this department as your source of information.

Or write to Information Section, Instruments Publishing Company.

Time Meter & Signal

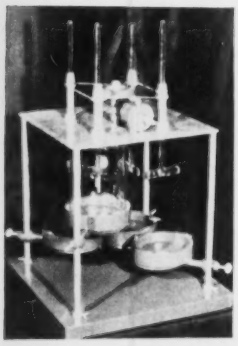
Supplementing meter's plain four-counting "Timeter," the new "Timeter with Indicating Lamp" embodies a bull's-eye lamp operated at low voltage which flashes during operating periods of the machine (or furnace, etc.) to which meter is connected. Max. registration 99,999.9 hours (or minutes, on special order); dimensions 3-9/16" × 3¼" × 2⅛"; rating 2 watts on 100-125-volt 60-cycle supply (other voltages and frequencies on special order).—*National Instrument Co., 14 School St., Boston, Mass.*

Heavy-duty Vibrators

A complete line of heavy-duty vibrators is announced, including models capable of operating a-c. equipment from d-c. lines at power levels up to 300 watts. Frequency stability adjustment is sufficiently accurate for applications which require automatic timing of processes; error at end of usual 24-hr. a-c. clock test is within 3 min. (— + 0.5%). Some models supply an a-c. output adjustable from 58½ to 61½ cycles; others convert 25-cycle or other frequency a.c. to 60-cycle a.c. In all models, each individual reed has its own adjustment.—*Electronic Labs., Inc., 132 W. New York St., Indianapolis, Ind.*

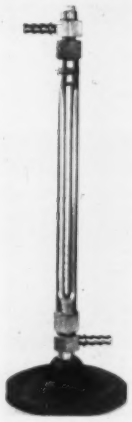
All-purpose Agitator

New "Air-way Stirrer" is a four-spindle agitator differing from conventional stirrer in several ways. Instead of rotating in one direction only, each agitating unit makes one complete revolution and then reverses. Power unit is a central air motor, controlled by a needle-valve throttle. The four stirrers can be used simultaneously or individually. Stirrer rods are of glass, ⅜" diam., easily inserted, removed or adjusted to desired depth; require no oiling. Motor operates on any air pressure above 2 lbs. in.². Absence of wiring assures safe starring of flammable liquids. Agitator capacity is four 1000-cc. beakers or utensils occupying equivalent total space. Overall dimensions 14" × 14" × 20" high; weight 15 lbs.—*The Schoolmaster Co., 3161 W. 116th St., Cleveland, Ohio.*



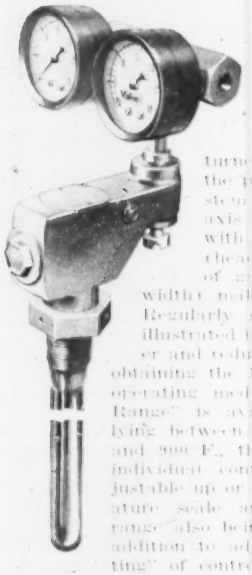
Sight Flow Meter for Laboratory

Developed for laboratory applications, new Sight Flow Meter is an enclosed type Rotameter (see *Instruments*, March 1938, page 81; April 1939, page 108) with knurled brass nuts holding the end fittings. These being hose-connector fittings, new model is chiefly intended for gas measurements. Crackle-black-finished base plate is extra-heavy.—*Fisher & Porter Co., 117 W. Penn St., Germantown, Philadelphia, Pa.*



Bi-metallic Stem Air-operated Temperature Controller

To "All Range" line of bi-metallic rigid-stem type air-operated temperature controllers (see *Instruments*, Aug. 1936, page 216; Oct. 1937, page 254; Nov. 1937, page 280) there is added a non-indicating "Junior Model" which may be installed with its stem at any angle to the vertical and may have its gages turned at any angle to the plane in which the stem axis and body axis lie. This, together with small dimensions (head 4⅝" deep, pair of gages 4¾" outside width) makes for flexibility. Regularly supplied but, not illustrated here, are a strainer and reducing regulator for obtaining the 15 lbs. in.² air as operating medium. "Junior All Range" is available in ranges lying between limits of 100° F. and 900° F., the range of each individual controller being adjustable up or down the temperature scale and its throttling range also being adjustable (in addition to adjustment or "setting" of control point). All adjustments can be made during operation. Construction is featured by stainless alloys and no need of lubrication.—*R. O. Bushnell, 3344 Mines Ave., Los Angeles, Calif.*

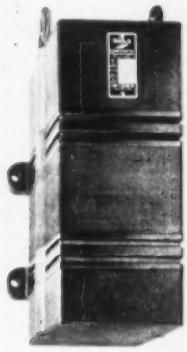


Pneumatic-electric Relays for Heat & Vent. Use

A line of electric-pneumatic relays is announced, among which are the following: *Tape R0464* for application to control fan and similar systems where it is desired to feed a considerable amount of air to control system from main air line when energized and to stop main air line and bleed branch line when de-energized. Also, there is its reverse-acting type, *Tape R0474 Electro-Pneumatic Relay*, for application to unit ventilators or small central fan ventilating or air conditioning systems where it is desired to feed air from main air line to outdoor air damper control motor when relay is energized from fan power circuit and to bleed air from this damper motor so as to close outdoor air dampers when de-energized. *Tape R0484 Diverting Relay* is air-operated and may be used to divert a source of air into either of two outlets, or to feed air to a branch line in one position and stop main line and bleed branch line in the other position. It may also be used to shut off an air line without bleeding the branch line. *Tape R0954 Grad-U-Relay* transmits control pressure from a thermostat or other controlling device to a greater number of control motors or valves than the controlling device, itself, is capable of operating; is of non-leak type which feeds or bleeds air to or from pneumatic motors only when a change is required; has a new type of cone check valve which is self-seating and air tight; may also be furnished in reverse-acting type.—*Minneapolis-Honeywell Regulator Co., 2956 Fourth Avenue South, Minneapolis, Minn.*

Constant-voltage Transformer

Said to provide a dependable source of "perfectly regulated a.c. unaffected by line transients or chronic high or low voltages," new constant-voltage transformer is announced in power range said to be low enough to permit its use for protective equipment applications. Suitability for diversity of requirements is accomplished by "unlimited flexibility of design in capacities." Among operating features is ability to maintain constant output voltage to within ½% from any input between specified limits; input power factor above 90% throughout entire operating range; low harmonic content to mean practically no distortion of output wave-form over entire operating range; over-all efficiency said to closely approach that of a well-designed double-wound transformer. Regulating action is automatic, instantaneous and continuous. With no moving parts and nothing to adjust, unit is said to require neither maintenance nor replacements. Transformer and its associated circuits are protected against damage by accidental short-circuits.—*Solar Electric Co., 2525 Clybourn Ave., Chicago, Ill.*



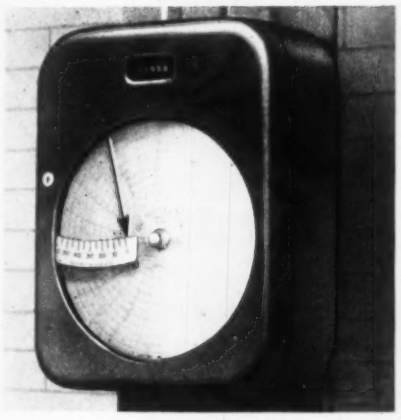
Wheelco "Radio Principle"

INDICATING CONTROL THERMOMETER

The combination of the famous Wheelco "Radio Principle" CAPACITROL controller and a bourdon tube assembly produces temperature indicating accuracy and control sensitivity unequalled by any other known method. A radio impulse does the work. There are no contacts or moving mechanical parts to interfere with the performance of this instrument.

Write for Bulletin 420J

Wheelco Instruments Co.
1933 So. Halsted St. Chicago, Ill.



How Important Is *Accuracy?*

WITH electric flow meters there must be no chance for lag or error in recording or integrating flow, for the cumulative effect of even slight discrepancies will be sufficient to make valueless the records upon which management must depend for important decisions.

Cochrane Electric Flow Meters, which are operated by the galvanometer-null principle, are guaranteed for their accuracy and dependability. They are reliable guides for compiling records of consumption, intake, output and variations in the rate of flow of steam, gases, water and other liquids.

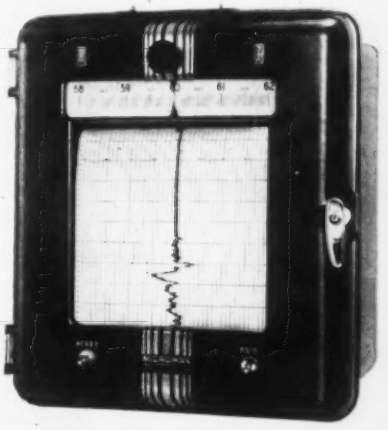
Write for Publication No. 2096.

COCHRANE CORPORATION
3120 N. 17th St., Philadelphia, Pa.

COCHRANE
FLOW METERS

Frequency Controller

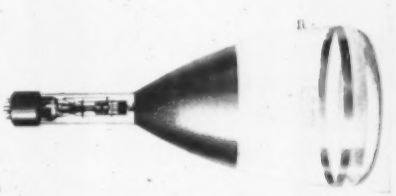
New Micromax Frequency Controller, industrial type, is said to provide isolated generating plants with automatic control of frequency which heretofore has been thought



feasible for large central stations on interconnected systems. It comprises, in one case, a Micromax frequency indicator-recorder and an automatic controller in the form of "a simple, relatively inexpensive arrangement which omits the refinements necessary for large central stations on interconnected systems." Measuring system is sensitive to 0.01 cycle; control system sends correcting impulses to governor motor on prime mover. —*Leeds & Northrup Co., 4955 Stenton Avenue, Philadelphia, Pa.*

Nine-inch Cathode-ray Tube

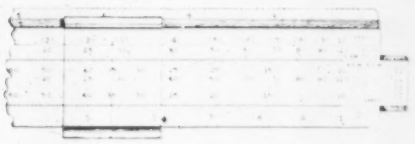
Intensifier rings which accelerate electrons after deflection was fully described in *Instruments*, March 1939, page 74. are a



feature of new "Type 91-11-T" 9" cathode-ray tube. Apart from its size, this new tube is similar to the 5" tube then described.—*Allen B. DuMont Labs., Inc., 2 Main Ave., Passaic, N. J.*

Industrial Slide Rule

Designed to solve "an unusual range of industrial problems, yet in a simpler way," with only one movement or setting of slide in majority of cases, new Langsner Indus-



trial Slide Rule is said to combine many rules in one. Face has six scales; two of them (above slide) represent feed, length of cut, and diameter; three of them (on slide) represent r.p.m., time, and cutting speed; regular D scale is below slide. Reverse side of the slide contains usual B, CI and C scales for standard slide-rule calculations. Three face scales are numbered in red, remaining three in black. Table on back gives frequently-used constants. Slide rule is 10" long, engine-divided on white celluloid, with glass "frameless" indicator, comes in a case with book of instructions. —*Engineering Instrument Co., 5725 Sheffield Ave., Chicago, Ill.*

BAILEY METER CONTROL SYSTEM

The Mark of Effective Control

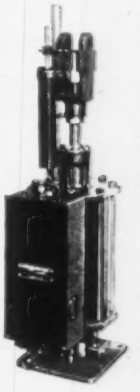
Process Control for sensitive, stable automatic control of temperature, pressure, liquid level, flow and other factors as applied to industrial processes. Responds to changes quickly, without overtravel or hunting. Ask for Bulletin No. 101.

Combustion Control that is simple but *complete* for providing economical operation of boilers of 200 h. p. and larger. Details in Bulletin No. 102.

Recorder-Controller

Boiler Meters for recording combustion conditions and guiding boiler operators. Described in Bulletin No. 44.

Multi-Pointer Gages for indicating factors such as draft, pressure, temperature and speed. These Gages are available with any number of pointers and any scale combination; in either the oil sealed bell or diaphragm construction.



Control Drive

Flow Meters for indicating, recording and integrating the flow of steam, water, sewage, air, gas and other fluids. Bulletins No. 39 and 300.

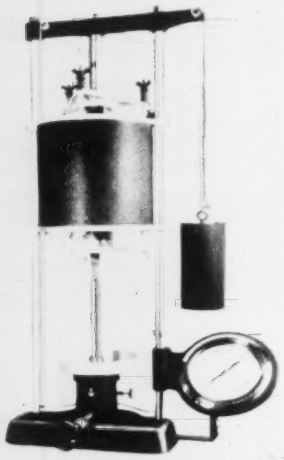
Recorders for pressure, temperature, drafts, liquid level and other factors.

C-1

BAILEY METER COMPANY
1041 Ivanhoe Rd., Cleveland, Ohio

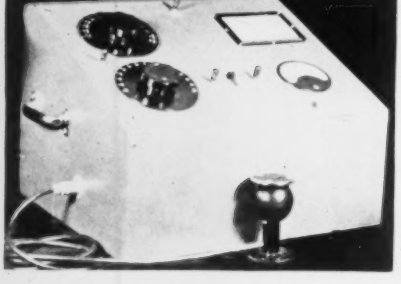
Dilatometer

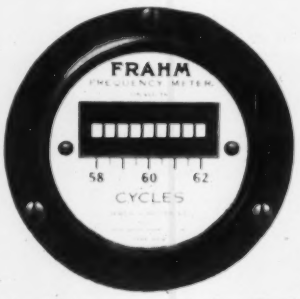
"Hitemphond" dilatometer measures behavior of molding and refractory materials at high temperatures, permits determining expansion, contraction, hot strength, hot deformation and rate of collapsibility of molding sands, cores, clays and refractory materials. Dilatometer consists of three essential parts: base containing a hydraulic loading mechanism, furnace which may be readily moved up and down on two vertical posts, and an electrical control unit (not illustrated). Hydraulic loading mechanism employs a screw-actuated piston; load is recorded on a special test gage with a maximum reading hand. Dilatometer may also be furnished with a dead-weight beam loading mechanism actuated by motor. Furnace contains a tubular Globube heating element which completely surrounds test specimen, may be brought up to 3000°F. in approx. 15 min. Terminals on furnace and supporting posts are water-cooled and require a ¼" cold water supply line. Weight 1200 lbs.; height 66", base 18" × 23"; rating 5 kva, 220-volt a.c.; strength range 0-1000 lbs. in 2, standard 1⅛" diam. sand specimens; temperature range 500-3000°F.; furnace I.D. 2" furnace length 32". *Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.*



Industrial Noise Analyzers

Two new models of Industrial Noise Analyzer are announced, having same basic features, but with controls arranged differently. (1) "Type RA-218" is intended solely for routine acoustic production testing in the plant; all controls not essential to routine testing have been eliminated from panel; frequency and decibel steps are identified by simple letters and numbers. (2) "Type RA-273" is intended primarily for applications where routine testing is done by engineers, or for both plant and laboratory. All controls of interest to acoustic engineer are provided. This model is full equivalent of maker's "RA-245" sound level meter and "RA-243" filter set in one case. *Electrical Research Products Inc., 195 Broadway, New York City.*





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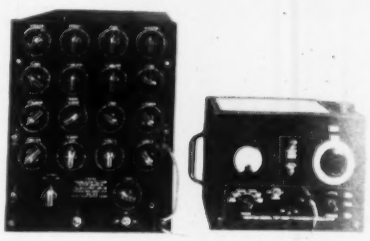
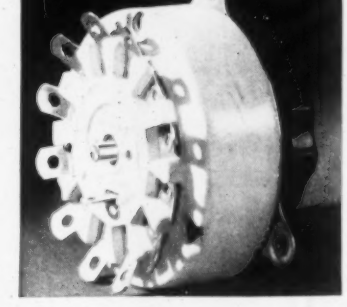
Television Signal Generator

"Type 202 Phasmajector Television Generator" has been developed to [illegible] high-definition television picture signals sufficient video output to modulate [illegible] termed ultra-short-wave signal [illegible] such as the Weston Model 787 high-frequency oscillator. Carrier frequency is variable from 30 to 150 Mc. and its modulation carries a standard high-definition television signal with synchronizing and blanking impulses. Instrument may also be used as a source of signal for video amplifier testing. It has three output circuits: Output A is a composite video signal of positive phase, containing picture signal and synchronizing and blanking pulses. Output B is negative-phase signal, otherwise same as A. Output C is same as B, except that video signal is superimposed on a d.c. component of approx. 30 volts. Composite video signal in all cases has a max. potential of approx. 10 peak-to-peak volts. Picture source is a DuMont "Phasmajector" cathode-ray tube with suitable test pattern or picture; its output is fed to the first stage of the video amplifier which has a substantially flat frequency response between 2[illegible] and 3,600,000 cycles. Compensating circuits correct both high- and low-frequency response to amplifier. Cutoff point of blanking amplifier is adjustable to provide for various blanking output levels. Output stage is a Type 6L6 operated as an impedance transformer to provide a low-impedance output for high-frequency signals. Instrument is entirely self-contained, with necessary power supplies for various functions and circuits.—*Allen B. DuMont Labs., Inc., 2 Main Ave., Passaic, N. Y.*



40-ampere Tap Switches

"Model 412" 10-amp. tap switch (illustrated) is one of a new series of heavy-duty rotary multi-point selector tap switches for battery chargers, x-ray equipment tapped transformers, arc and spot welder motor controls, etc. It is said that "never before have so many high-current taps been so completely arranged yet perfectly insulated." Model 412 is rated for 240-volt non-inductive circuit, is 4" in diameter, comes with a maximum of 12 contacts. Other features: silver-to-silver contacts; cam and roller snap-action; designed for single or tandem mounting. *Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.*



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Matching the unusual sensitivity of the Famous CAPACITROL control system with the well established accuracy of the potentiometric method of temperature measurement. Wheelco again leads in supreme performance by offering this unbelievable solution for control problems of extreme accuracy and sensitivity.

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Available in a number of double range combinations, such as 1 volt and 1 volt, 100 MV and 10 MV; also in pH ranges. Guaranteed accuracy .1%. An outstanding value.

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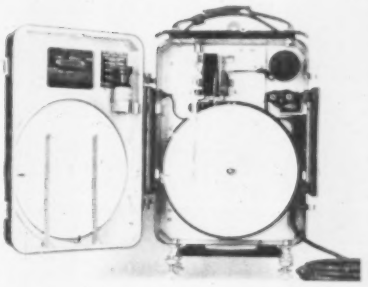
29 North 6th Street Philadelphia, Pa.

Round-chart Portable Recording Voltmeter

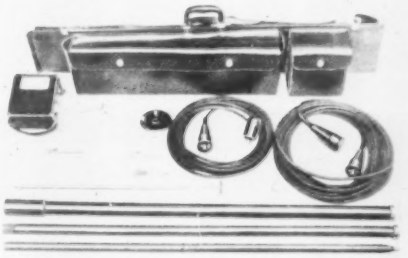
A new round-chart portable recording voltmeter, "Model 522MS," built specially for survey work, is a light-weight, self-con-



tained instrument housed in a weatherproof case for indoor or outdoor service. It is equipped with adjustable mounting legs for pole or wall mounting.—*The Bristol Company, Waterbury, Conn.*

Line Insulation and Bushing Tester

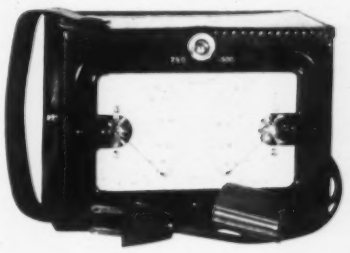
Construction of new "Hipot" Insulator and Bushing Tester is essentially as described in Feb. 1937 *Instruments*, page 38. Principal changes are: a more sensitive in-



dicating instrument, a change-over switch for high and low voltages, special prongs and leather carrying case as illustrated. Older equipment is *not* withdrawn; it still is recommended for insulator testing.—*Rolfe-Smith Co., Bethlehem, Pa.*

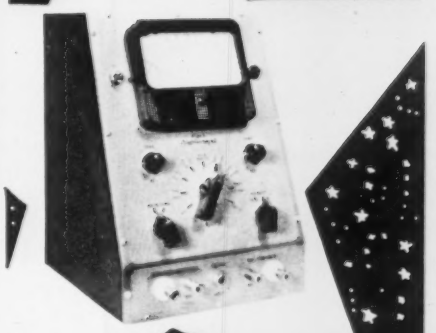
Power-consumption Tester

Designed for rapidly testing power consumption of fractional-h.p. motors, etc., under actual running conditions, Model 2000



Triplett Portable Appliance Tester has a wattmeter and voltmeter—twin instrument style—whereby line voltage and wattage can be read simultaneously. Direct wattmeter readings are 1500 watts at 220 volts, and 750 watts at 110 volts. Dual voltmeter scale reads 150-300. A push button is provided to protect the wattmeter during starting periods. Case is heavy leather, 3-1/16" × 5⅞" × 2⅛". Not visible in illustration is a leather flap that folds over twin instrument and snaps in place when tester is not in use.—*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

Outstanding



10 BILLION TO 1

LIKE THE STARS IN THE HEAVENS ten billion to one is beyond comprehension, yet that is the ratio of the resistance range of the Rider VoltOhmyst. Electronic engineers have been quick to visualize the lasting usefulness of this new Electronic D-C Voltmeter-Ohmmeter with ranges wide enough for the engineering requirements of today and tomorrow. It is designed for use on television, radio facsimile and aircraft receivers and transmitters, sound power, and other engineering work.

The Rider VoltOhmyst measures 0.05 to 5000 volts D-C in nine ranges—0.1 ohm to 1,000,000,000 ohms in seven decade ranges with a greater convenience than any other existing instrument. As an example, you can measure any D-C control or operating voltage wherever it may be without being concerned with the circuit complications—with the signal present in the circuit. For, the Rider VoltOhmyst has one scale—one zero adjustment. You just put the proper probe on the point to be measured and the scale shows the voltage or resistance without any adjustments as you change ranges. 3% accuracy on the Ohmmeter, 2% on the Voltmeter. Input resistance of the Voltmeter is 16,000,000 ohms up to 500 volts and 160,000,000 ohms from 500 to 5000 volts.

Operates over 105-130 volts, 25-60 cycles. **NET PRICE $57.50**

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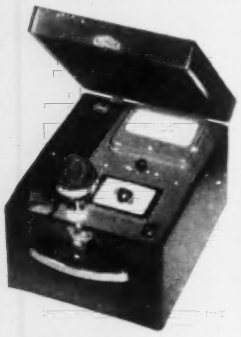
The RIDER VoltOhmyst

Portable Sound Level Meter

For measuring sound intensity in design and survey work, "Pattern 15 Soundmeter" has a calibrated microphone and sys-



tem of specially-designed amplifier, housed in a portable carrying case "hardly larger than a camera," permits measuring intensity of any sound or noise "within range of human ear," is said to be simple to operate, requires no external power source, its amplifier being supplied entirely from self-contained batteries. Range is 50-125 db in steps of one decibel each. A weighted response curve is employed, meeting specifications set up by American Acoustical Society.—*John Meck Instruments, 167 N. Main St., Chicago, Ill.*

New Electrometric Method of Chemical Analysis

With new "Elecdropode," both qualitative and quantitative analyses can be conducted in both organic and inorganic chemistry. It permits making current-potential measure-

ments in a special type of electrolytic cell, operation of which is based upon two phenomena: (1) under proper conditions, when dropping mercury electrode is employed, an ion in solution makes its presence known by a current increase which takes place at a definite voltage; (2) there is a definite relationship between amount of current increase at that voltage and concentration of the ion causing that current increase.

Instrument employs a fine glass capillary and means for supplying mercury to it (the so-called dropping mercury electrode). A beaker containing the unknown solution is placed under this capillary and varying potentials between 0 and 3 volts are applied, with a precision of ±0.005 volt, to the drops of mercury as they fall through the solution. A suitable measuring instrument indicates the current. All these parts are assembled in a case with Bakelite panel on which are mounted the controls and dials. Instrument is self-contained, operates from 110-volt, 60-cycle a.c. supply, uses ex- narily small amounts; it actually best in the range 0.01 to 0.0001 equ per liter and, under special conditio tensive analytical work has been co with as little as 0.005 cc. of solution ple is not changed and may be recov further work after analysis. Though ment employs a new method, "a gre of work has already been done with it cessful applications reported includ Pb & Cd in commercial Zn; Cu, Ni & steels; Fe, Mn, Cu, Bi, Pb, Cd, Zn, N in ash of plant tissue; traces of fatty and alkaloids; analyses bearing on t for structure and reaction mechani *Fisher Scientific Co., 711 Forbes St., burgh, Pa.*

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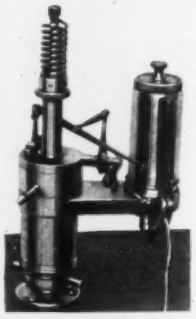

It *is* a high-speed "engine" indicator, and it is just what you need for recording all pressures in all YOUR work.

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Flow Telemetering System

New flow-rate telemetering system employs "Synchro-Meter" electrical transmission method fully described in *Instruments*, May 1937, page 124, but its transmitter is actuated by a positive-displacement meter. It differs from the usual flow-recording attachment for displacement meters in that it

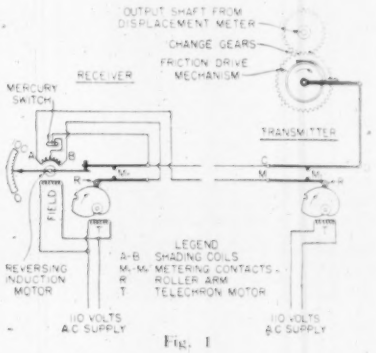
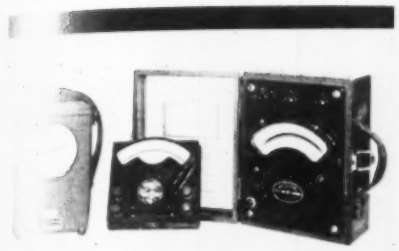


Fig. 1

indicates and records flow-rate instead of drawing a succession of arcs. No change or modification of parts of the displacement meter is required for attachment of Synchro-Meter transmitter drive. Contact arm *CD* is connected to a friction drive mechanism so that operation of displacement meter causes it to descend until contact M_1 is made. Contact M_1 remains closed until constant-speed cams driven by Telechron motors *T* reach their maximum throw. At each cycle, contact arm *CD* descends a distance proportional to rate of flow through the

Fig. 2.

placement meter. It is this rate reading which is transmitted once each cycle. At receiving end, recording and indicating instruments are positioned by a reversing induction motor which runs in one direction when shading coil *A* is short-circuited and in other direction when coil *B* is short-circuited. In all other respects, operation is as previously described in these columns. New system is said to be particularly useful for indicating and recording the rate of flow of fluid which cannot be satisfactorily measured by orifice type meters. It may be used also as a tachometer for indicating or recording the speed of any rotating shaft, especially at low speeds (1 to 5 r.p.m.).—*Bailey Meter Co., 1041 Ivanhoe Rd., Cleveland, Ohio.*



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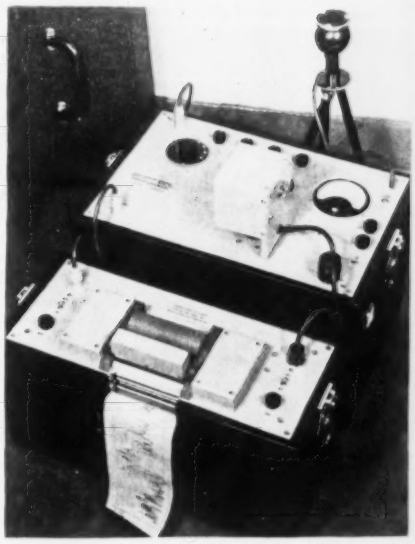
Rapid-recording Sound Frequency Analyzer

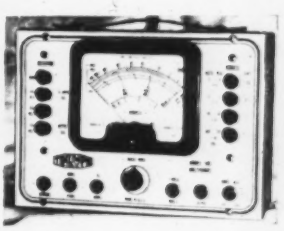
Announcement of new "RA-281" recording frequency analyzer outfit emphasizes that it is the first "coordinated equipment engineered specifically for the purpose"; that all elements were designed at the same time specifically to work with one another; that stylus and paper speeds, filter suppression



and other characteristics were not just what happened to be available but were chosen carefully; and that result is a record which is detailed but clean and open, permitting accurate interpretation. "RA-281" consists of: (1) "RA-277" Sound Frequency Analyzer, a continuously-variable sound frequency analyzer of narrow band width and associated level measuring equipment—complete in itself as an indicating sound level meter and frequency analyzer, tunable between 10 and 10,000 cycles. (2) Drive motor for sweeping dial of RA-277. Two interchangeable motors are supplied: a 1-min. motor for 10-1000-cycle range and a 2½ min. motor for 100-10,000. (3) "RA-246 Graphic Level Recorder" which plots levels on a linear db scale—with displacements proportional to logarithms of input voltages. Chart width 11½"; chart range 50 db; recording speed 58 db/sec.; drive speeds 0.078, 0.2355 or 0.628 in./sec. (4) Western Electric "630-A" transmitter; the familiar "s-ball" microphone. (5) Carrying case, extension cables and cords, etc.—*Electrical Research Products Inc., 195 Broadway, New York City.*

32-range Tester

Brought out to anticipate television receiver servicing in addition to present requirements, new "Model 330 Multirange



Meter" covers 32 ranges including a-c and d-c volts, d-c, amperes and milliamps., ohms, megohms and decibels. Mirror-scale indicator has 400-microamp. sensitivity, 7500-volt insulation for 3000-volt ranges. Overload protection on resistance ranges is automatic. Overall dimensions 9" × 7" × 4"; weight 4 lbs.—*Triumph Mfg. Co., 1017 W. Lake St., Chicago, Ill.*

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CAPACITANCE C
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THIS FINE INSTRUMENT will be useful in many ways in your laboratory. With it you can simply and speedily measure inductance, capacity and resistance over extremely wide ranges, as shown below.

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Extremely portable, weighs only 5 1 2 lbs . . .
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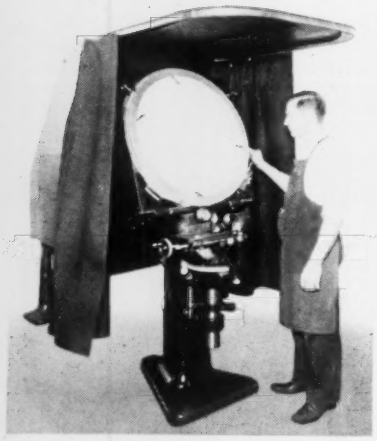
RCA Test Equipment
RCA Manufacturing Co., Inc., Camden, N. J.
A Service of Radio Corporation of America

Projector Type Comparator

New model of maker's Comparator and Measuring machine has a 30" diameter screen to permit optical inspection of relatively large objects at suitable magnifica-



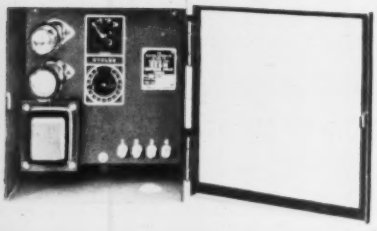
tion. The following lenses can be furnished:

20× (will project a 1½" area object);
30× (will project a 1" area object);
50× (will project a 0.6" area object);
100× (will project a 0.3" area object).

Periphery of the 35" diam. ring which supports screen is graduated to 0.5° and vernier reads to one minute of arc. Comparator will accommodate objects 8" in diam. by 21" long, has provisions for measuring 4" on the coordinates, is furnished with any one of three types of table: C1 plain, C2 with 4" lateral travel, C3 with 8" lateral travel. Table may be swiveled to position helix of hobs and taps normal to axis of lens system. Lead measurements on the tables with lateral travel may be accomplished by use of micrometer attached to table, by spacing blocks or end-measuring bars. An attachment can be supplied for measuring, by reflection, surfaces that cannot be projected.—*The Jones & Lamson Machine Co., Springfield, Vermont.*

Weld Timer

For use with spot, butt and projection welding machines, to automatically control the length of time the current is allowed to flow through pieces being welded, "Neotron" weld timer employs capacitor charge



& discharge principle. When used on 60-cycle frequency its timing range is from ½ to 60 cycles, set by means of dials on front of panel. (Time intervals do not include the time constant for operating magnetic contactor.) For greater intervals than 60-cycle maximum, another timer has a time range from 1 to 120 cycles. Periods up to 300 cycles can be secured when required. Automatic non-repeat form, with non-heat and hold features, is available for operation on air-operated welding machines. Another form, the automatic-repeat, has non-heat, hold and squeeze features and is used on air-operated gun welders. Overall dimensions 9" × 8½" × 7" deep.—*The Electric Controller & Mfg. Co., 2706 E. 79th St., Cleveland, Ohio.*

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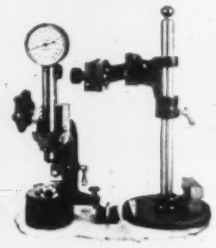

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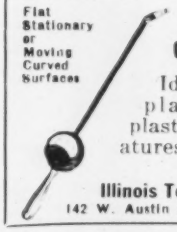

The "Alnor" Combination Pyrocon

Ideal for rolls, molds, plates, platens and plastic material temperatures.

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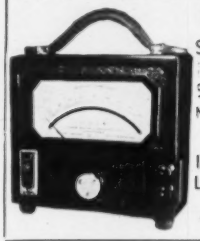
Illinois Testing Laboratories, Inc.
142 W. Austin Ave. Chicago, Illinois

NEW "ALNOR" PORTABLE PYROMETER



Shock Resisting, Floating Movement, Has 5" Mirrored Scale Metal Case.

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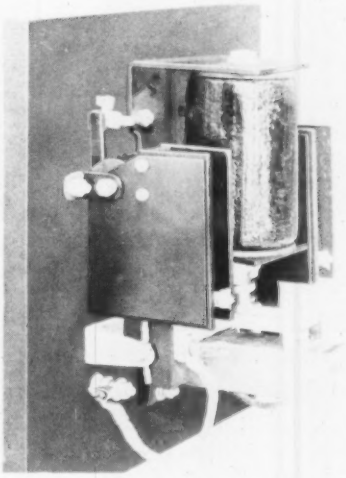
Control Relays

Designed for service between contr[ol] a control switch or push button and [the] breaker or other apparatus to be con[trolled] when current-carrying or current-int[errupt]



ing capacity of switch or push button is less than current required by apparatus to be controlled. "Type C" Relays are available as single-pole or two-pole devices. Contacts are given a maximum current and voltage rating based on intermittent duty, are silvered copper to silvered copper and have a sliding and rolling action. Relays may be had with coil assemblies for either ac or dc operation. Trip-free or non-trip-free operating mechanisms are available. Mechanism with trip-free feature provides a means for automatically opening contacts of control relay approx. 1 sec. after control relay operating coil has been energized. Trip-free feature is inherent in relay, requires no interconnecting wiring between relays and breaker, operates regardless of position of breaker at end of 1-sec. interval. Regular mounting is ¾" ebony asbestos panel; special panels carrying relays, knife switches and fuses can be supplied, also metal enclosures.—*Roller-Smith Co., Bethlehem, Pa.*

Stiffness Tester

New model of "V-5 Stiffness Gauge and Triple-Cut Shear" (see *Instruments*, June 1938, page 1641) embodies various refine-

ments. Sensitivity 0.05 g.-cm. in the 0-10 range; guaranteed accuracy ±0.5%.—*Tabor Instrument Co., North Tonawanda, N. Y.*

Vacuum . . . Thermocouples

COMPLETE LINE

embodying many unique features

★

- DEPENDABLE STABILITY
- MORE EFFICIENT
- HIGHER OVERLOAD
- FASTER RESPONSE
- SMALLER SIZE—1/2"x1"
- LOWER COST

These thermocouples will meet the most rigid specifications. Prompt delivery is assured. Write your requirements to:

AMERICAN Electrical Sales Co., Inc.
67 E. 8th St. New York, N. Y.

ELECTRONIC DEVICES

HIGH VACUUM APPARATUS

MERCURY SWITCHES

LAMPS and TUBES of All Types

SPECIAL GLASS CONSTRUCTIONS

METAL TO GLASS SEALS

★

Made to suit your requirements

★

A complete Engineering and Manufacturing service

★

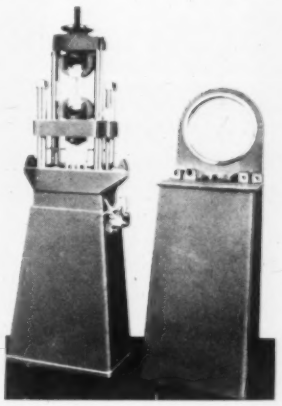
15 years' experience with the instrument trade

★

George E. Fredericks
8031 Jeanes St. Philadelphia, Pa.

Universal Testing Machines

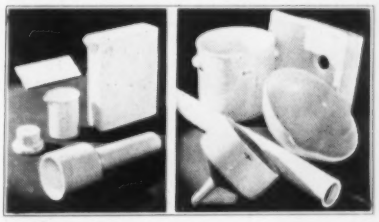
To maker's line of relatively small equipment are added a 60,000-lb. universal tester (illustrated) and similar machines in smaller capacities, all said to represent most modern practice "at surprisingly low cost."



Machine may be adapted for special purposes. Compression space may be increased; screw and handwheel at top provide adjustment for tensile specimens of different lengths. Load is applied hydraulically by motor-driven pump. Pump, motor, reservoir, etc., are located in base of machine. Movement of a valve lever runs ram up or down rapidly; and rate of loading is automatically maintained by an auxiliary valve. Transverse table, posts, head, etc., are full-floating while tensile testing, to prevent misalignment of specimen or friction in ram. For transverse or compression testing, floating unit is guided. Change may be made instantly without tools. Ram and cylinder are of the ground, packless type. Additional load gages of different ranges and grips of various types are available to specification. If necessary to conserve space, load gage or gages may be mounted on wall back of machine. *Specifications:* Max. capacity, 60,000 lbs.; Ram travel (may be increased) 4"; Transverse specimen (may be increased) 2" × 2" × 24"; Compression specimen (may be increased) 12" × 12" × 6"; Space between tensile jaws to specifications; Height overall approx. 7 ft.; Front width (without gage stand) 30"; Depth 21". *Detroit Testing Machine Co., 5147 Trumbull Ave., Detroit, Mich.*

Ceramic Ware

Numerous utensils for laboratory and plant uses are announced, all made of a new porcelain having the following characteristics: specific gravity 2.41; absorption



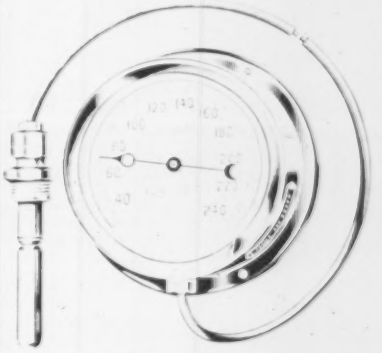
(fuchsine dye test) at 100,000 lbs./in.2; zero compression strength 100,000 lbs./in.2; modulus of rupture (glazed) 15,000 lbs./in.2; linear thermal expansion 0.000023 F.; thermal conductivity 8.4 B.t.u. ft.2 in. hr. F. Body is white, dense, uniform, without blebs, voids or communicating pore spaces. Glaze is hard, translucent, glass-smooth; white is standard, colors are available. Possessing such characteristics, new Lapp Porcelain is being used also for making products other than laboratory ware: piping, high-pressure filter parts, grinding balls and mill linings, etc. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

MOELLER PRECISION GRADE INSTRUMENTS

★

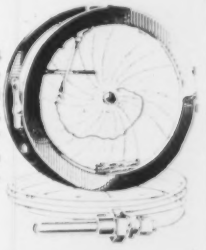
Our mercury thermometers are made with the Moeller Glass Red Reading Column which makes them easy to read under varying light conditions, at a considerable distance and over a wide range.

★



Moeller dial thermometers are made in various scale ranges up to 1000 F. or equivalent in both Metal and Phenolite cases.

Moeller recording thermometers are likewise furnished in various ranges up to 1000 F. or equivalent in both round and square cases.



Other products include

HYGROMETERS
RECORDING PSYCHROMETERS
BAROMETERS HYDROMETERS
MARINE INSTRUMENTS, ETC.

Write for catalog.

MOELLER INSTRUMENT COMPANY
132nd STREET and 89th AVENUE
RICHMOND HILL NEW YORK

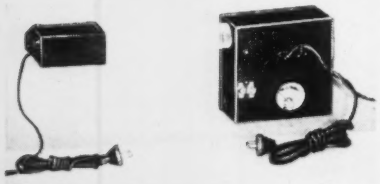
Portable Automatic Flue Gas Analyzer

Though classifiable as a "hand Orsat" by reason of its portability and its use of the absorption method, new "Orsatomat" auto-

matic flue gas analyzer indicates CO_2 and draft by pointer-and-scale, as do control-board instruments (see *Instruments*, Oct. 1936, page 274). In new model, greatest change is in the tilting analyzing unit which is now composed of Lucite transparent plastic instead of hard rubber as formerly. It is lighter (weight 12 lbs. charged), more compact, housed in newly designed pressed-steel case with a draft indicating unit. Both units are removable. If desired, a flue gas thermometer may also be had to fit inside the case.—*The Hays Corp., Michigan City, Ind.*

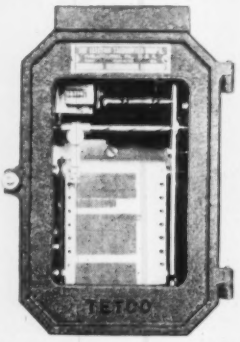
Infra-red Source, Relay and Amplifier

A complete outfit is announced, similar to photoelectric control equipment except that its source produces—and its photocell responds to—infrared radiation instead of light. Because of its obvious principal ap-



plication, it is designated as "Rehtron Burglar Alarm Robot." Principal class of industrial applications includes detection of smoke, especially smoke which appears to be almost transparent; amplifier and relay can be adjusted to respond to presence of a smoke or fume density which will not absorb enough radiation in the ... spectrum to operate the usual photo... equipment at the usual sensitivity ... ment. In other words: new equip... anti-false-alarm provisions make it ... for smoke-detection applications, w... purely photoelectric outfit, adjusted ... vent false alarms, would not be suff... sensitive. Employment of a balanc... cuit with two radiation receivers ... sates for varying levels of sunlight ... field illumination and serves as an ... tional stabilizing feature.—*Rehtron D... A. C. Eckhardt Co., 2143 N. Magnolia ... Chicago, Ill.*

TETCO
Speed Recorder



Creates a permanent time record on a waxed chart. Accurately records rate of production, time and duration of stops, total quantity produced

The Electric Tachometer Corp.
1358 Spring Garden St., Philadelphia, Pa.

A & A COILS
Magnet *Established 1924* Solenoid
Electrical Coil Winding Co.
2736 Saunders St., Camden, N. J.

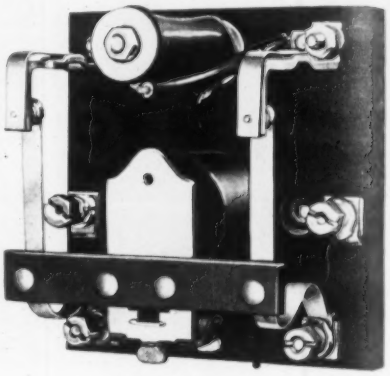
The All Purpose
AIR VELOCITY METER

"Alnor" Velometer
Instantaneous
Direct
Reading
No Timing
No Calculations
Write
for Literature
ILLINOIS TESTING LABORATORIES, Inc.
142 W. Austin Ave. Chicago, Illinois

★ *NATIONAL* ★
RHEOSTATS
Ask for Catalog No. 5
National Electric Controller Co.
5317 Ravenswood Ave., Chicago, Ill.

Safety Relay

Safety Relay No. 507-516 has been developed for installation on amateur radio transmitters to protect the operator against

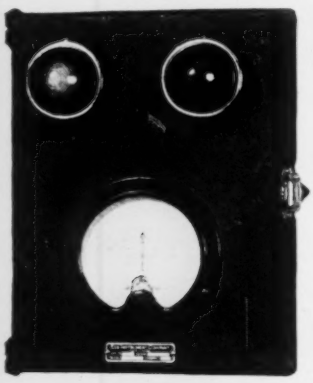


shock from static charges. Its coil is connected across the 115-volt primary of the high-voltage plate transformer and its contacts across the output of the filter circuit. Thus it automatically discharges the filter condensers after each transmission.—*Ward Leonard Electric Co., 37 South St., Mount Vernon, N. Y.*

Thermostat for Hot-plate Varnish Tester

Developed for a prominent paint & varnish firm, new electrically-operated thermostat has provided solution of problem of maintaining surface temperature of hot

plate polymerization-point determination apparatus within ± 1°F.; is said to hold surface temperature within — 0.5°F. during final factory test; is obviously suitable for control of temperature of liquids, as in various laboratory apparatus baths and other applications requiring constant temperatures. Extreme limits of available range are —30°F. and 400°F.—*Thermo-Electric Co., 1012 W. Superior Ave., Cleveland, O.*



PRECISION COMBUSTION
REQUIRES INSTANTANEOUS, SENSITIVE, INFORMATION

The HAZEGAGE "Electric Eye" Combustion Indicator is the *fastest* instrument on many modern panel boards. It enables automatic controls to be set *more precisely*—often on ten-second information.

It *notifies* firemen when "out of bounds"

Ess Instrument Company
30 Irving Place, N.Y.C.

WE WERE ASKED

Why Rectangular Gage Blocks Are Best

1 Their time-proved shape makes rectangular blocks convenient for gagemakers and toolmakers to handle. They're much easier to use in the "tight" places.

2 Rectangular Johansson Gage Blocks are more adaptable for use with accessories. Blocks and holders, light in weight, make accurate work easier.

3 They're only as thick as they need to be, no extra bulk. They "wring" together easily, eliminating the need for rods or screws. Using blocks without holes, the gage man makes his set-up at the center of the block, the area of greatest accuracy.

4 Rectangular blocks were the first type developed. Others were adapted from them. The rectangular shape can be used on jobs where other types cannot be used.

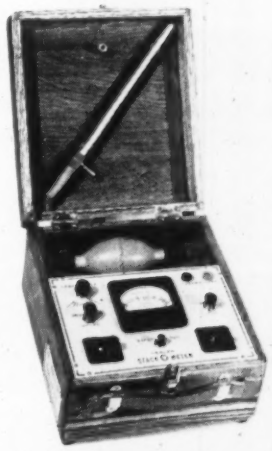
5 Compared with square-type blocks, the narrow measuring surfaces of rectangular blocks have a tendency to wear evenly. That's why Johansson Gage Blocks in constant use remain accurate for a long time.

JOHANSSON GAGE BLOCKS

Ford

Portable Stack-temperature and CO_2 Instrument

"Stack-o-Meter" is a portable outfit (case 9" × 11" × 6" deep) comprising a CO_2 meter and a flue-gas temperature indicator, both electrical. Sampling hose, hand aspirator bulb and sampling tube (with thermo-



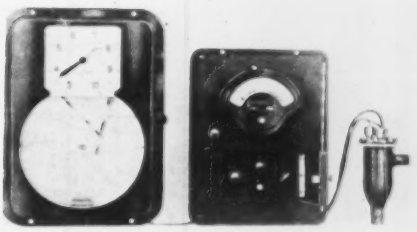
couple) are contained in carrying case. One indicator serves both purposes: its dial is graduated 0-20% CO_2 in black figures and 0-1000°F. in red. Flash-light batteries (obtainable at local stores) require replacement every month or two depending on service, are the only maintenance expense. Thermal conductivity bridge principle is used in CO_2 meter (ref. Bureau of Standards *Technical Paper No. 259*). A safety switch automatically opens battery circuit on closing cover.—*Wm. O. Hebler Co., Central Ave. at Long Ave., Hillside, N. J.*

Conductivity Bridges

A series of two models and two combinations is announced, comprising an a-c bridge for 110-125 volts, 50 to 60 cycles (Model RC-11 or 110 and 220 volts, 25 to 60 cycles (Model RC-21) and conductivity cells for solutions of low (or low and medium) conductivity, with attachable thermometer. Bridge utilizes 3-volt input voltage obtained through transformer; output voltage is fed to single-stage vacuum-tube amplifier which in turn is coupled to a cathode-ray null indicator instead of a galvanometer. Scale length of 5-range indicator is approx. 14". Total range of bridge is 0.2 to 250,000 ohms; for electrolytes, 0.2 ohm to 2 megohms. Cabinet dimensions 11" × 8¼" × 7½"; weight 11 lbs.—*Industrial Instruments, Inc., 162 W. 23rd St., Bayonne, N. J.*

pH Recorders and Controllers

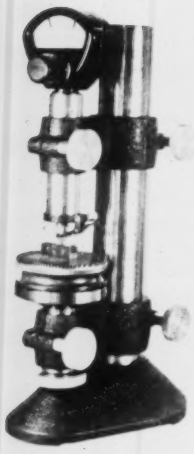
New pH recorders and controllers employing the glass-electrode method of measurement and designed especially for industrial plant use are offered in two general types, wide strip-chart model and round-chart



model. Automatic controllers are offered in both electric and air-operated models. Each instrument can be plugged into any standard light circuit, fluctuations in line voltage being automatically compensated for. Shielded glass electrode is completely sealed and internally shielded from electrostatic interference; companion calomel electrode has a factory-filled internal assembly, immersed in saturated KCl solution contained in outer tube of electrode. Electrolytic connection between internal assembly and solution under measurement is maintained through a small hole protected by a ground-glass sleeve. Two types of electrode assemblies are offered: (1) Enclosed Flow Type (solution under measurement is pumped or allowed to flow through chamber) and (2) Immersion Type (designed for immersion in tanks and vats). Both are of size convenient to handle, are rugged enough to require no special handling precautions, can be used in viscous or even semi-solid substances and in rapidly circulating or flowing liquids. Compensation for temperature changes is automatic.—*The Bristol Co., Waterbury, Conn.*

Gage Comparator

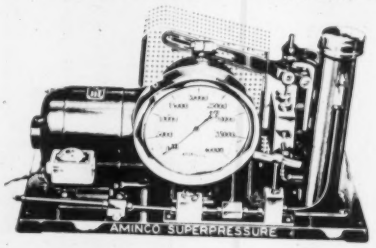
Designed for external measurement of precision parts, gages, etc., new type of comparator called "Mikrokator" is said to employ a "revolutionary principle of friction-



less amplification which assures positive repeat readings of unusual accuracy." It has no friction bearings, gears, levers, or other moving parts subject to wear. Makers particularly emphasize that instrument has no electric lights or electromagnets, hence no heating source, hence no need of a warming-up period to stabilize instrument temperature. Having no electrical connections, instrument can be moved about, or mounted on special checking fixtures. These instruments are furnished with scales graduated to 0.0001", 0.00005", and 0.00002", readable to one-half scale division. New principle utilized in amplifying mechanism resides in a metal strip twisted in a helix. Pointer is mounted in center of this strip, which is twisted left-hand on one side of pointer and right-hand on other side. One end of strip is anchored to a rigid member, other end to a movable member. Latter transmits spindle movement to twisted strip; is hinged on a flat spring. Spindle carrying measuring tip transmits its movement to this movable member, thereby pulling twisted strip lengthwise and causing it to unwind or untwist, thus moving the pointer. Upper end of spindle is attached directly to this member, and lower end supported in a metal diaphragm. Entire mechanism is under tension at all times. Backlash and loose-play being totally eliminated, reading of the instrument is exactly the same when spindle moves up as it is when it moves down. For example, if a plug gage is rolled under measuring tip, spindle moves up to maximum reading which is the correct size; then starts to move down. In measuring a flat piece, or when setting the instrument with Johansson gage blocks, operator lifts spindle by means of lifting lever; places block under measuring tip, and releases lifting lever to take reading. "Mikrokator" gives the same reading in either case. *Swedish Gage Co. of America, 7316 Woodward Ave., Detroit, Mich.*

High-pressure Pump for Tests

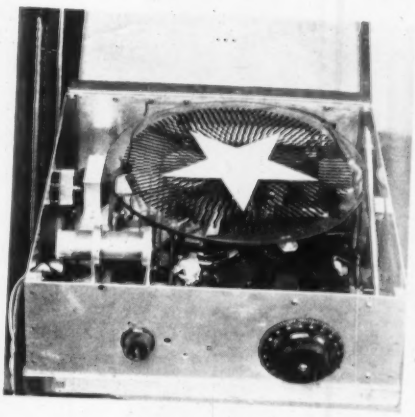
New motor-driven hydraulic pump is latest addition to maker's line of high-pressure testing equipment (see *Instruments*, Oct.



1937, page 2511). It is designed to supply constant pressures from 10,000 to 30,000 lbs./in.^{2} in steps of 5,000 lbs./in.^{2}.—*American Instrument Co., 8010 Georgia Ave., Silver Springs, Md.*

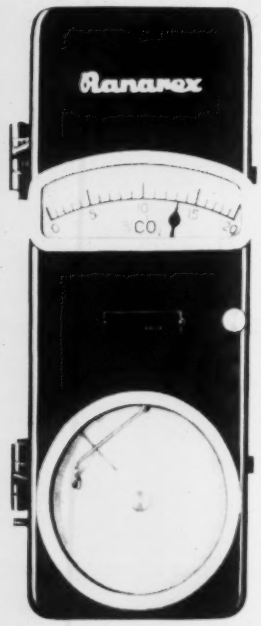
Automatic Planimeter

Measurement of areas of patterns other irregular plane objects) is accomplished electrically by newly-developed "Stockton Polar Integrator." Novelty



method lies in that instead of measuring area in terms of the decrease of instantaneous illumination or "shadow area," instrument successively *scans* a number of unit areas or "spots" and performs addition by actual count, so that limit of error cannot exceed the unit for which the particular instrument has been planned. Result of measurement appears on a direct-reading decimeter counter. Illustration shows an instrument with a 100-in.^{2} total area and a 0.1-in.^{2} unit area, as built for a Massachusetts industry. Others are being made with various total areas and with unit areas as small as 0.01 in.^{2}.—*Stockton Precision Gauge Corp., 165 Jackson St., Lowell, Mass.*

The Only MECHANICAL CO_2 INDICATOR AND RECORDER



30 FT. DIAL READABILITY . . . PERMANENT RECORD

RANAREX CAN TAKE IT!

Ranarex is extremely accurate, extremely responsive, yet it is not delicate. . . . Far from it! Actual operation on naval maneuvers has proved even gun-fire shock can't affect its rugged mechanical heart! And Ranarex "beats the gun" for speed . . . you get almost instantaneous readings! Operates on lighting circuit. No chemicals, no fragile parts.

Can Be Calibrated to

1. Measure CO_2 in flue gas
2. Measure Gas Density
3. Measure Quality of Controlled Atmospheres
4. Analyze Special Gas Mixtures
5. Analyze Internal Combustion Engine Exhaust

PERMUTIT

Dept. A8, 330 West 42nd St., New York

WRITE FOR BOOKLET! Contains details of new portable Ranarex model, 16¾" high, 8" wide. Weighs 29 lbs. Quick readings. Saves time, saves money.

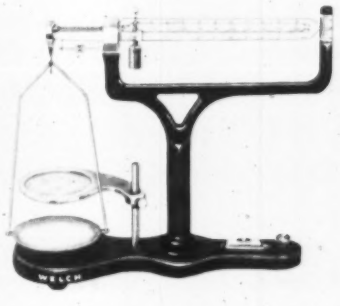
...cket Size CO_2 Indicator

...pocket-size CO_2 indicator, trade-...Fyrite," specifically designed for ...plers and service men, is said to ...ically unbreakable, and to employ ...ely new principle which makes it ...ly simplicity of use and fool-proof ...ion." A complete analysis is said to ... from 20 secs.: A dozen strokes of

...spirator bulb fills gas chamber with the ...ple gas to be analyzed. Sampling hose is ...n detached, which automatically seals de...ance and makes it ready for analysis. To ...ix the gas with the absorption fluid, "Fyrite" is turned upside down, then back ...gain to normal position. This takes about ...0 secs. Suction created due to absorption ...of CO_2 draws absorbing fluid up graduated ...ube and its level shows percentage of CO_2 ...in the gas. No setting up is required. "Fyrite" as received is ready for use; absorbing fluid is good for several hundred readings. "Fyrite" is furnished complete with aspirator bulb, filter, rubber tubing and metal sampling tube, in carrying case which has room for maker's "Draftrite" gage and a pencil-type stack thermometer. Whole kit weighs about 4 lbs., measures $8\frac{1}{2}$" × 7" × $2\frac{3}{8}$". *Bacharach Industrial Instrument Co., 7008 Bennett St., Pittsburgh, Pa.*

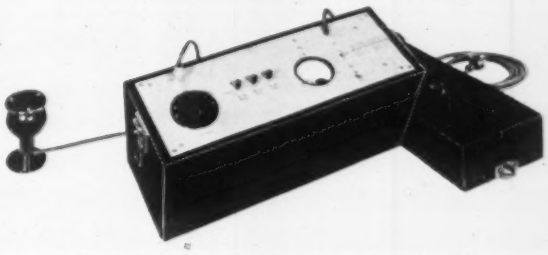
Triple-beam Balance

...Generally similar to No. 1032 on page 336 of maker's latest catalog, a new "stainless-steel model" has just been developed for



...routine weighings in chemistry laboratories. ...Only part not of stainless alloys is cast-iron ...support. Heavily coated with vitreous enamel. All knife-edges and bearings are agate, whereas heretofore only bearings were ...agate. Ranges of three beams and extra ...weight give capacity of 1110g.; sensitivity ...0.05g.; pan is $5\frac{1}{4}$" with bows 6" apart.— *W. M. Welch Mfg. Co., 1515 Sedgwick St., Chicago, Ill.*

Here's the only
AC-OPERATED NOISE METER



Type RA-215 Sound Level Meter meets A. S. A. Standards

Because it is AC-operated, the type RA-215 is the most *convenient* Sound Level Meter you can use. Its feedback amplifier eliminates the necessity for field calibration. It has no batteries to replace.

And it's *accurate*—calibrated from Bell Telephone Laboratories standards. Stability is insured by moving coil microphone and feedback amplifier.

The RA-215 design is based on years of consulting experience in acoustic, noise and vibration control. It is thoroughly *practical* for you.

Write for detailed bulletin.

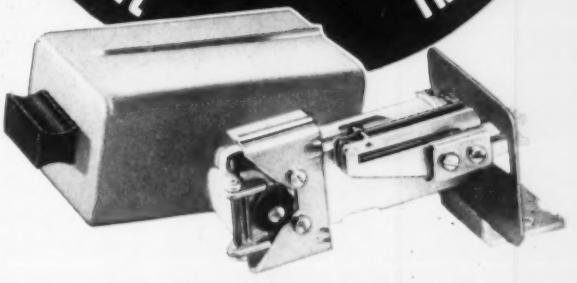
Electrical Research Products Inc.

SUBSIDIARY OF

Western Electric Company

195 BROADWAY, NEW YORK

ELECTRONIC **CLARE RELAYS** INDUSTRIAL



"Clare Individualized Relays" is not merely a trade slogan. They are individualized to your specific requirement—the individual need of the modernized electronic controlled machine. A far-reaching recognition, resulting from co-operation in engineering relay design application — close tolerances in production — ability to maintain lasting adjustment in the field and render precise, unfailing service. Clare Individualized Relays are highly essential to intricate electrical control and indicating.

Write for Catalog CC1

CLARE ELECTRO MECHANICAL SPECIALTIES RELAYS

C. P. CLARE & CO.

LAWRENCE & LAMON AVES. - - CHICAGO

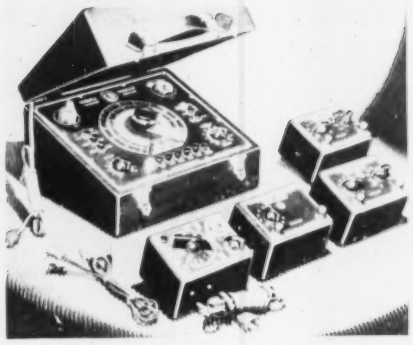
15 EAST 26TH STREET.. NEW YORK CITY

Throttling Electric Valve for Proportional Control

Employing a new principle and characterized by simplicity of design and construction, "Wheelco Electric Valve" has been developed for regulating the flow of gas, oil or air to furnaces, ovens, etc., under control of "proportioning" control-mode instruments. Motive unit utilizes differential thermal expansion of two coaxial tubes fixed to each other at one end, their other ends fixed respectively to valve "seat" and valve "disk" (actually two multi-orifice disks). This "motor" has an O.D. approx. ¼ of body I.D. Valve opening is a function of current flowing through low-thermal-capacity heating element which elongates inner metal tube; therefore, changes from one position to another are asymptotic: quick initial response and gradual slow-down, preventing over-correction. Proportionality characteristic (max. opening for a given control-zone low-point) is adjustable by placing a rheostat in the control circuit. Valves are available in capacities to 10,000 ft.³/hr. of air, to 5000 ft.³/hr. of gas and to 100 gals./hr. of 250°F.-preheated oil.—*Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.*

Electronic Switch

Capable of operating with contact resistances up to 500,000 ohms, new Electronic Switch is applicable wherever it is desired to do away with sticking or arcing contacts on thermostats, small limit switches and any type of equipment requiring extremely low contact pressures. Makers recommend it also for control of chemical solutions and similar electrometric applications. Switch may be operated in any position, in any temperature up to 150°F. Dimensions 3¼" × 3⅛ × 3½" high. Power output 3 watts at 110-volt 50-60-cycle a.c. Control contact requirements are 500,000-ohm limit and 10-microamp. current-carrying capacity. Production starts June 15 (illustration shows pilot model) and makers emphasize that price will be below $5 in 100-lots.—*United Cinephone Corp., 43-47 Thirty-third St., Long Island City, N. Y.*

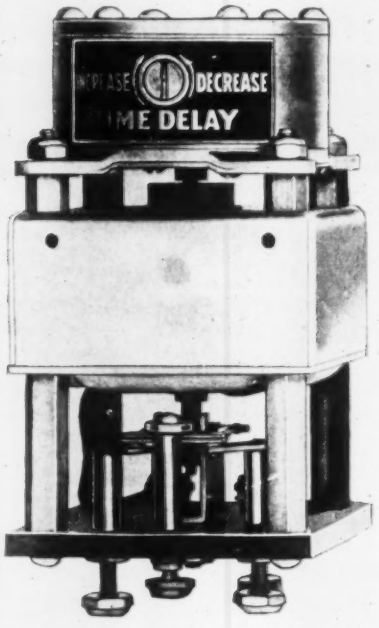


Capacitor Decade Boxes

Commercial accuracy of ± 5% is adhered to in standard production models of a new series of hermetically-sealed capacitor decade boxes employing mica and DyKanol capacitors. Special decades, with a tolerance of ± 3%, are also available. Charts are supplied giving exact capacitance of each segment. For instance the .2 mfd. section will be indicated, on chart as .202 mfd. or whatever exact capacitance of that unit may be. Calibration markings are directly in microfarads. Decades are supplied in three units with a range of 0.0001 mfd. to 11.1 mfd. These can be used in circuits where voltages do not exceed 220-volt a.c. or 600-volt d.c.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

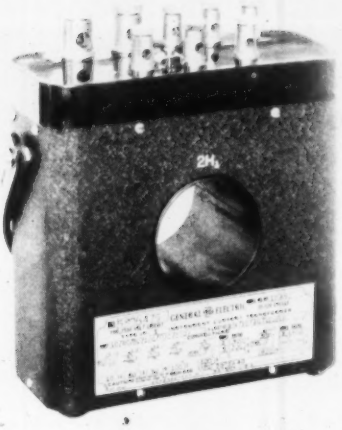
Automatic Timer

Though recently designed for industrial purposes, "Type NA-12 Agastat" employs diaphragm type timing head, which maker has been supplying to U.S. and foreign lighthouse service for twenty-five years. New timer is of instantaneously-recycling type, for introducing in an electric circuit (various a-c. and d-c. ratings up to 5 amps.) a time delay which may range from "a fraction of a second to several minutes" but which is adjusted at factory. Eighteen arrangements of contacts, etc., are available.—*American Gas Accumulator Co., Elizabeth, N. J.*



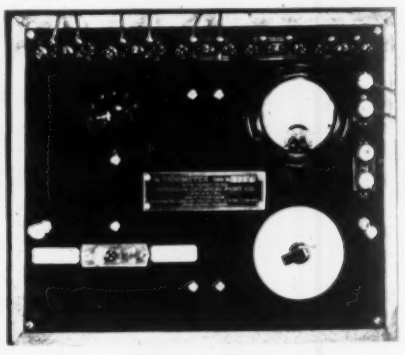
Portable Current Transformer

Designed especially for field testing, [illegible] current transformer is portable and sufficiently accurate for use with portable [illegible] instruments. Its core window is 2¾" in diameter. Primary ratings of 10/20/50/100 amps. are obtained from a wound primary with terminals on top of the case. Passing primary cable through the core window once obtains ratings of 600/800 amps.; passing it through two or more times obtains ratings of 150/200/300/400 amps. Rating of secondary is 5 amps. Primary and secondary connections for the various ratios are indicated on diagrammatic nameplate.—*General Electric Co., Schenectady, N. Y.*



Conductivimeter for Alkaline Cleaning Solutions, etc.

Developed for facilitating chemical control of solutions used in bottle-washing machines, etc., new "Ridometer" is a conductivimeter designed for use by plant personnel; operating from a-c. line, unaffected by fluctuations in line voltage between 85 and 130 volts, compensated for changes in temperature of solution, provided with double scale graduated for specific washing compounds, and other special features. Two distinct types of immersion cells are available: C1 for solutions containing high percentages of caustic soda; C2 for rinse solutions, etc. Both are easily inserted in relatively small space in tanks of any machine; their resistance is unaffected by metallic objects not closer than 2", or by depth of immersion beyond 1" from surface.—*American Chemical Paint Co., Ambler, Pa.*



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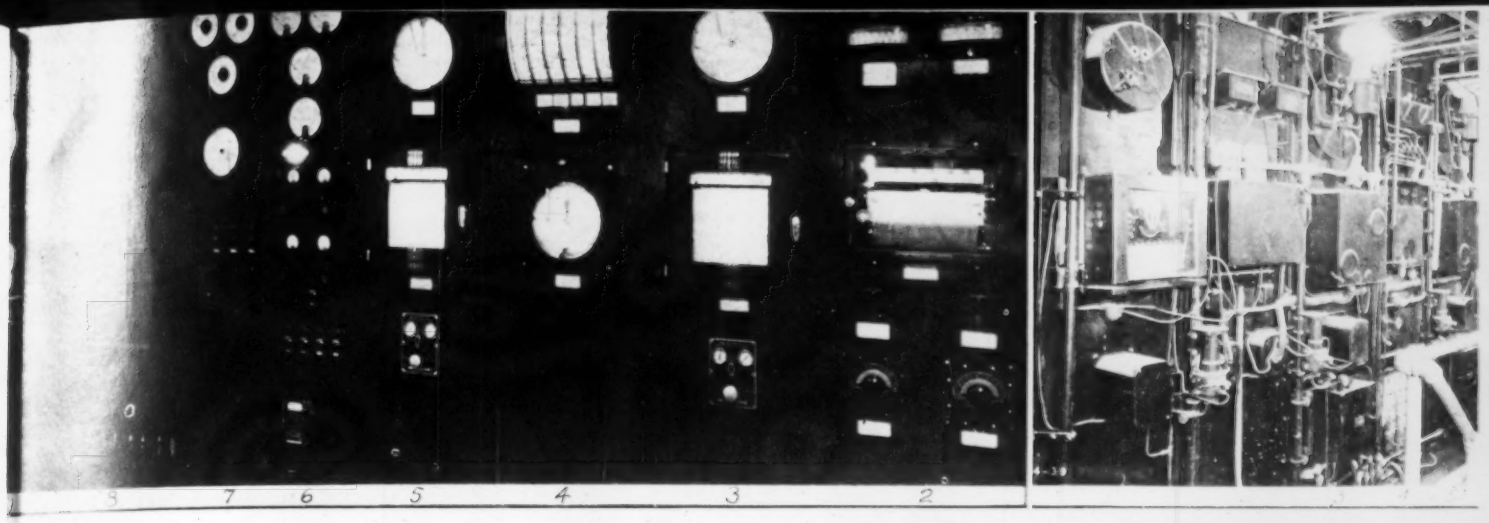


Front and rear views of control board on No. 3 electric furnace and acid plant, Fertilizer Works, Wilson Dam, Ala.

Instrumentation of a TVA Electric Furnace Phosphoric Acid Plant

By J. N. JUNKINS and ROGER H. NEWTON
Chief, Chem. Eng. Design Div. Senior Chemical Engineer
Tennessee Valley Authority, Wilson Dam, Alabama

ALTHOUGH an experienced operator can control a reasonably complicated piece of chemical equipment largely by "feel," it is generally conceded that better operation, higher quality product and lower costs result from the judicious use of indicating and control instruments. Instrumentation provides also means of recording certain variables, a knowledge of which is useful in tracing difficulties, and in comparing the efficiency of different shift operators. In the first operation of a new type of equipment, instruments are an absolute necessity, since minor difficulties will absorb the attention of the operators and the operating conditions will not be adequately observed. Still another reason for use of instruments is to provide test data, so that a detailed analysis of operation can be made through material and heat balances, in studying the means of obtaining the maximum efficiency and minimum cost from a unit. The number of instruments should be as small as will adequately provide the necessary control data; however, accurate and reliable instruments are generally too few rather than too many. The proper choice of type of instrument and location is of considerable importance, since a single instrument can frequently be made to provide information of the immediate control of the unit, a record of what has happened, and data useful in analyzing the results of operation.

Comprehensive articles[1] have been published on the electric furnace phosphoric acid plants of the Tennessee Valley Authority at Wilson Dam, Alabama. However, for those who may not have read the articles, the process will be briefly described in order that the instrumentation problem may be better understood. The plant, which is to a large extent housed in the buildings of the old U. S. Nitrate Plant No. 2, consists of three electric furnaces, two rectangular in shape and one cylindrical. All furnaces are operated at a load of approximately 5500 kw. The phase voltage is 180 and the line amperage averages 20,000 at a power factor of 85% or better. The current is carried into the charge by three 30" carbon electrodes. The furnace is charged continuously from overhead bins through chutes with a properly proportioned mixture of phosphate rock, silica and coke. Under the heat of the electric arc the phosphate rock is reduced by the coke to form calcium silicate slag which is tapped from the furnace, granulated by water jets, and pumped to the waste pond, and elemental phosphorus and carbon monoxide come off the furnace as a gas through an appropriate offtake pipe.

The furnace gas is handled in two ways: On two of the furnaces it is passed into a condenser where the phosphorus is condensed out and the CO pumped to the Raw Materials Department where it is used as a fuel gas for drying and nodulizing raw materials. The other furnace is provided with a combustion chamber in which the phosphorus - CO mixture is burned at once and the products of combustion, namely P_2O_5 and CO_2, passed to a hydrating chamber where the P_2O_5 is made into phosphoric acid (H_3PO_4) by contact with a water spray, thence to a Cottrell precipitator where the acid mist is collected, the waste gases passing up the stack.

The condensed phosphorus is stored in underground tanks under water from which it is pumped to the burners where it is burned to P_2O_5 and hydrated, as just described, except that in one system a packed tower is used in place of the Cottrell precipitator. The phosphoric acid formed is stored until ready to be used in the manufacture of triple superphosphate fertilizer.

From the foregoing description it will be seen that such a plant requires many kinds of instruments to measure the temperatures, pressures, drafts, flows, volts, amperes and power and to control the proper relations of the various plant functions.

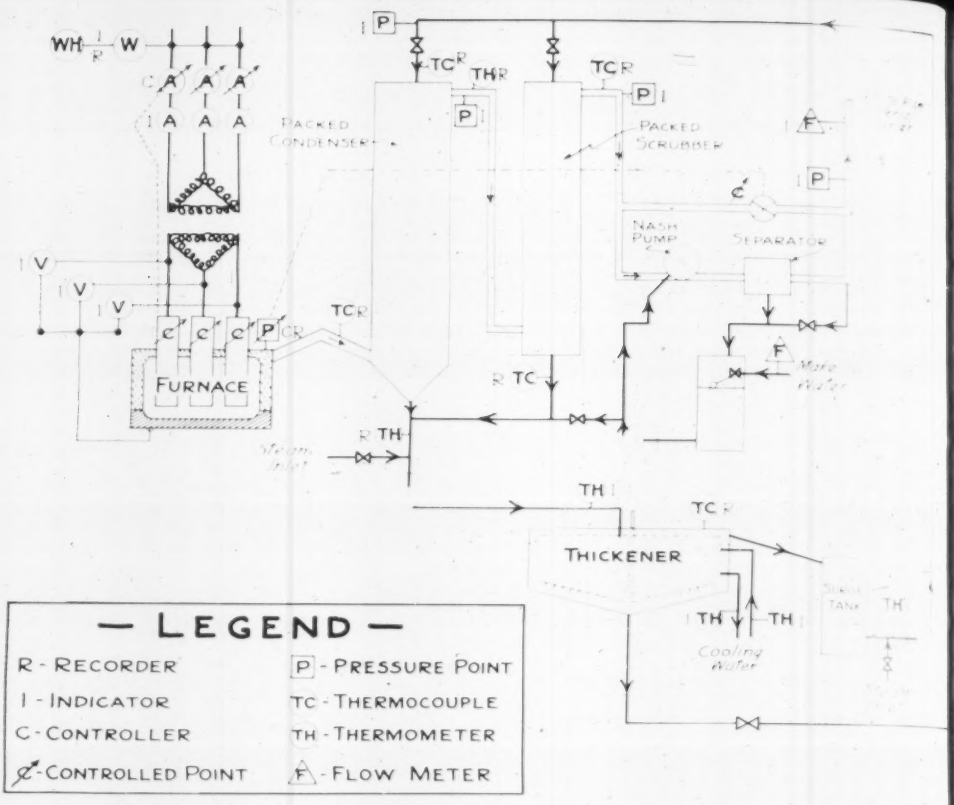
Determining the Instruments

After a project has been thoroughly investigated and its feasibility agreed upon, a flow sheet is prepared early in the design stage embodying the principal features required for a full-size plant, as indicated by the data obtained from the pilot plant operation. Such a flow sheet is shown herewith. From this flow sheet the control points where instruments are required are determined and the conditions at those points are calculated or taken from pilot plant data. From these data the grouping of instruments is made and the proper type for each measurement or control application is selected. An instrument diagram is then prepared, using the flow sheet as the basis, showing the function of, and connections to each instrument. After this diagram has been checked and approved, the actual locations of the instruments and control are deter-

[1] See Bibliography.

mined. For this purpose, two principal factors are considered, namely, is the instrument for recording, for process control, or for both; and if for control, where should the control point be located to give the operator the best and easiest control?

The basic function of the Department of Chemical Engineering of the T.V.A. is that of research, even though that research is on a full (plant-size) scale. Therefore, after the normal operating points have been considered, a check is made with the plant research section to see if the instruments already determined upon will serve their purpose; if not, there are added the instruments which are required in order to collect data which later may be used in studies of plant economy and process improvement. The additional instruments provided for such research purposes are industrial type thermometers in all cooling-water lines to and from the units; and water meters located in by-passes in all supply lines. These instruments are readily removable, but are frequently maintained in service to check certain conditions.



Some instruments originally installed for research have proved so useful that they have been retained for control purposes, and their use has been incorporated in the newer designs. Thus a sensitive pressure recorder was installed on the No. 2 Furnace to record the frequency and severity of furnace puffs, and especially to bring out a comparison between manual and automatic control of the draft. Its use resulted in steadier operation and lower off-gas temperatures, and incidentally demonstrated the advantages of a calcined furnace charge, so a furnace draft recorder is now in use on all furnaces. Flowmeters measuring the flow of exit gas to the plant stack, likewise originally installed for research purposes, have since proved a valuable aid in minimizing air leakage into the systems and in determining P_2O_5 losses in a routine manner.

A recording radiation pyrometer has been used to measure the temperature of the slag tapped from the furnace. In this case, however, the inter-relation between this temperature and other variables of furnace operation was complex, so the instrument was not used for control purposes, although several times since its removal it has been necessary to take this temperature manually by an optical pyrometer for periods of a week or more.

When the above points have been determined, a list of the instruments is prepared giving their function, range, type, whether indicating, or recording, and the type of automatic or remote manual control, if required. This list is then checked by the instrument engineer with his stock to see if any instruments are on hand which may be adapted. If none is found, he prepares the proper specifications for the project engineer.

The T.V.A. being subject to the rules that govern purchasing by governmental agencies, it is necessary that we prepare rather complete specifications setting forth exactly what we wish to purchase in such terms that quotations will be received on the exact equipment we want without preventing any reliable manufacturer from bidding on his standard equipment because some unimportant feature has been specified too closely—which would be detrimental to both the bidder and the Authority in that the bidder would fail to make a sale and the Authority would fail to get a satisfactory piece of equipment at the lowest cost.

After the bids are opened, they are carefully examined and the award made to the lowest bidder meeting the specifications. When all the awards have been made and drawings received from the successful bidders, the diagram is checked and revised if necessary to agree with any detail found to be different in the instrument actually purchased from the original conception. The next step is the designing of the instrument board, for it is the Authority's belief that centralized control has, to date, been justified in the efficient operation which has come from having the entire chain of the process under the control and observation of one man. This board is laid out so that the instruments pertaining to each step of the operation are grouped together if possible, particularly the electrical instruments and meters. Electrical instruments are surface-mounted on slate or ebony asbestos boards and other instruments are usually flush-mounted on sheet steel boards.

THE INSTRUMENTS USED

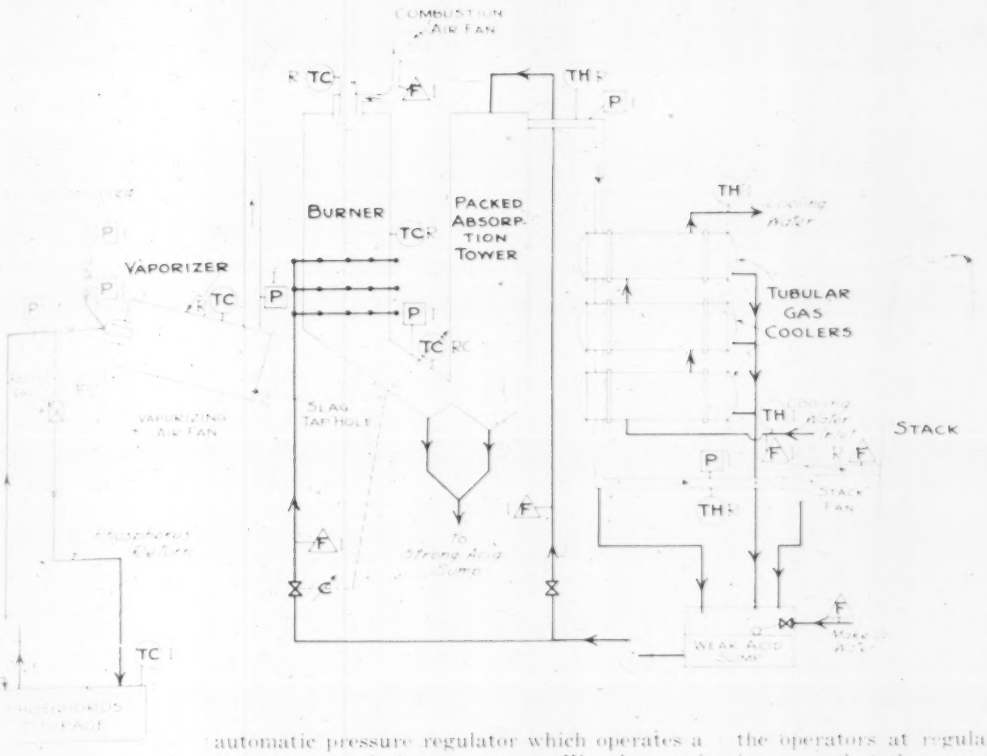
Electric Furnace

Each electric furnace proper requires the following instrumentation: Three indicating ammeters showing amperes per phase; three indicating voltmeters, showing the arc voltage between the electrode and the carbon furnace bottom or crucible. The current is controlled automatically by contact-making ammeters which operate the electrode winches that raise and lower the electrodes.* A constant and equal arc voltage on all three electrodes is maintained, and hence the regulating ammeters are set to give this condition at the constant kilowatt load determined upon. Indicating, recording, and integrating wattmeters are also provided for control and information purposes.

Condensing Plant

In this section, in which the phosphorus is condensed from the furnace gas, we are concerned with the following measurements: temperatures of gases leaving the furnace; temperatures of gases leaving the condenser; temperatures of the liquid entering and leaving the condenser; temperature of the liquid in the thickener; gas pressure in the furnace; gas pressure at condenser inlet and outlet and scrubber towers; and gas pressure at outlet of gas pumps. The furnace pressure, which must be kept as nearly balanced with atmospheric as is possible to prevent infiltration of air or egress of gas, is controlled by means of an

*These electrode controls are adapted from the original carbide furnace controls, although a new and better type of control equipment has been developed in recent years and is in use on commercial furnaces of this type.



automatic pressure regulator which operates a by-pass around the gas pumps. We also need to know the quantity of CO being discharged from the furnace and an orifice type indicating flow meter is provided in the pump discharge line. Liquid pressure gages are provided at all points where needed. The condensed phosphorus is stored under water and is kept in molten condition and it is required to know the temperature of this phosphorus.

Acid Plant

The elemental phosphorus from the storage tanks is pumped to the burning or combustion chamber and the resulting P_2O_5 hydrated to phosphoric acid. Here it is needed to know the temperature of the gases in the vaporizer, the temperature in the main burner outlet, the waste gas temperatures at the outlets of the hydrating tower and of the gas cooler. The quantity of air supplied to the vaporizer, and to the secondary air inlet; the total volume of the gases leaving the system, the water supplied for cooling and hydration purposes, are all metered. The water supplied for hydration is automatically controlled to maintain fixed temperatures at the hydrator exit.

SELECTION OF INSTRUMENTS

Temperature Measurements

Corrosion is one of the major problems that we have to face in our plants as hot phosphoric acid is extremely corrosive. Because of the frequent replacement required due to corrosion, thermocouples give the best service even at the lower temperature ranges where some sacrifice must be made in accuracy. However, by careful inspection of protective wells, etc., resistance thermometer bulbs and gas-filled control instrument thermal systems have been maintained with but few replacements.

The Authority has standardized on potentiometer instruments for thermocouple work and, where no control is involved, a multiple-record type with a maximum of six records on one chart is used. Experience has shown that when more than four records are made the instrument should print the record by numbered dots, especially if it is to guide the operators who control by hand. Since the gas temperatures normally fall throughout any system, it is quite feasible to record all these temperatures on a single instrument, so that they appear in numerical order and give at a glance a picture of the entire operation.

The specification for such instruments calls for automatic cold-junction compensation and either automatic standardization against the standard cell or the furnishing of an air cell battery as a source of current if manually standardized. Most of the instruments are subject to considerable temperature fluctuation and ordinary dry cells have not been found satisfactory for manual standardization. All recorders are required to have an easily-readable indicating scale.

Because of the corrosion problem just mentioned all recorder thermocouples are connected also to an indicating millivoltmeter type pyrometer through a selector switch, so that the operator can verify the proper operation of the couple and recorder. In addition, a second thermocouple is provided at critical spots and is also connected to the indicating pyrometer. The indicating pyrometers are read by the operators at regular intervals and are useful in making sure that the operator is keeping track of the various temperatures since he must record all indicated temperatures on the log.

In the lower range of temperatures (up to 1800° F.) iron *vs.* Constantan couples are used; from 1200 to 2500° Chromel *vs.* Alumel; and where the temperatures exceed 2500° platinum *vs.* platinum + 10% rhodium.

All thermocouples are made in the instrument laboratory. A large number are made at one time, tested, and several picked at random from the lot are carefully standardized as a check on the quality of the wire. One thermocouple is also made up from each new purchase of wire and standardized to see that it meets specifications.

For low and medium temperature applications where corrosion-resistant wells can be provided, resistance thermometers are used. Examples: the cooling water and the off gas from the hydrator towers and condenser, and the condenser liquor outlets. The instruments are of the multiple-record type having four bulbs and recording in colored dots.

For the lower temperatures where information is desired only for observing operations, especially where readings must be not only accurate but always reliable, metal cased industrial type mercury thermometers are used with corrosion-resistant bulb wells.

Pressure Measurements

All pressure and draft instruments used for operation are indicating vertical-scale illuminated instruments of the multiple type. Those above the operator's eye level have inclined scales, so as to minimize parallax. Where records are desired, each indicating gage is parallel with a round chart pressure or draft recorder. Most of the pressures involved are low enough to permit using instruments of the flexible diaphragm type. For example, the pressure on the furnace roof is recorded by an 8" round-chart instrument having a range from 0.3" pressure to 0.3" suction. For measuring pressures of all non-corrosive liquids, except phosphorus, Bourdon-tube gages are used. Where accuracy is desired for control purposes 8" dials are provided, otherwise 4" dials are used. The pressure of corrosive liquids or elemental phosphorus is measured by diaphragm type gages with corrosion-resistant diaphragms and pressure chambers. In case of phosphorus gages, the entire diaphragm chamber is wound with a copper steam tracer and insulated to prevent solidification of the phosphorus.

Liquid and Gas Flow Measurements

For manual control purposes, the flow of primary and secondary air to the combustion chamber and the gas discharged from the absorption equipment are measured. Where sufficient pressure drop is allowable an orifice is used; where it is necessary to recover the velocity head a Venturi throat is used.

In Venturi meters for gas flows it has been found that throats constructed of steel plate in our shops are sufficiently accurate for control purposes (± 2%), especially if calibrated in place. Normally the angles of each Venturi are 60° and 30°, since this facilitates manufacture, conserves space and still allows recovery of about 80% of the velocity head.

Water flow is generally totalized with regular water meters, except where flow-rate measurement is desired for research purposes, in which case Venturi throats or orifice plates are installed in conjunction with differential gages.

The old nitrate plants were well provided with integrating and recording differential meters of various types, a large number of which had never been used—most of them Bailey Meter Co. and Builders Iron Foundry plus a few of the old-type General Electric instruments. These meters are used, where adaptable, for all research work and for operation control data. When sensitive records are desired and a low pressure is involved, especially on gas flows, a differential meter of the diaphragm type is used. This type of instrument is used for the stack fan outlets and for combustion air flows where pressure differentials are low.

Automatic Control

The question of automatic control is one given considerable study and the installation of automatic control equipment is predicated on previous results of manual operation except in such applications as controlling the balanced pressure in the furnace where it is a known fact that proper control cannot be had manually. Frequently, any automatic control system which does not function perfectly from the start is put into disuse by the operating crew, who usually figure that they are better than any machine—which argument sometimes applies to controls which *do* work the first time. It therefore is necessary that such control systems be properly conceived and the operators be sufficiently educated in their purpose to have the necessary confidence in them.

Automatic control is used throughout the plant for maintaining the balanced pressures on the electrical furnaces and for maintaining the outlet temperatures of the gases from the hydrator tower.

The pressure controls for No. 2 and 3 furnaces are of the Bailey type using inverted bell jar type control instruments which, through a pilot valve, operate pneumatic cylinders. In No. 2 unit, the cylinder controls the speed of the stack fan and in No. 3 unit it operates a butterfly damper in the by-pass around the gas pumps. The furnace pressure on No. 1 unit is maintained by a diaphragm and air jet controller of the Askania type operating a hydraulic cylinder which is connected to a damper in a by-pass around the gas pumps.

The hydrator outlet temperatures on No. 2 and No. 3 units are controlled by a temperature controller of the Bailey type with a bulb inserted in the hydrator outlet. The temperature of No. 1 is controlled by a Brown potentiometer-Askania system from a thermocouple inserted in the hydrator outlet.

In order that proper cooling may be accomplished and at the same time proper acid strength be maintained, it is necessary that the hydration water be finely atomized. To obtain this fine atomization, the pressure must not be less than 125 lbs./in.^{2}. To control this temperature, the spray water flow is varied by adjusting the pressure between 125 and the line pressure of 250 lbs. To accomplish this, the control valves by-pass a manually-operated regulating valve which is set to give a minimum of 125 lbs. when the automatic control valves are entirely closed.

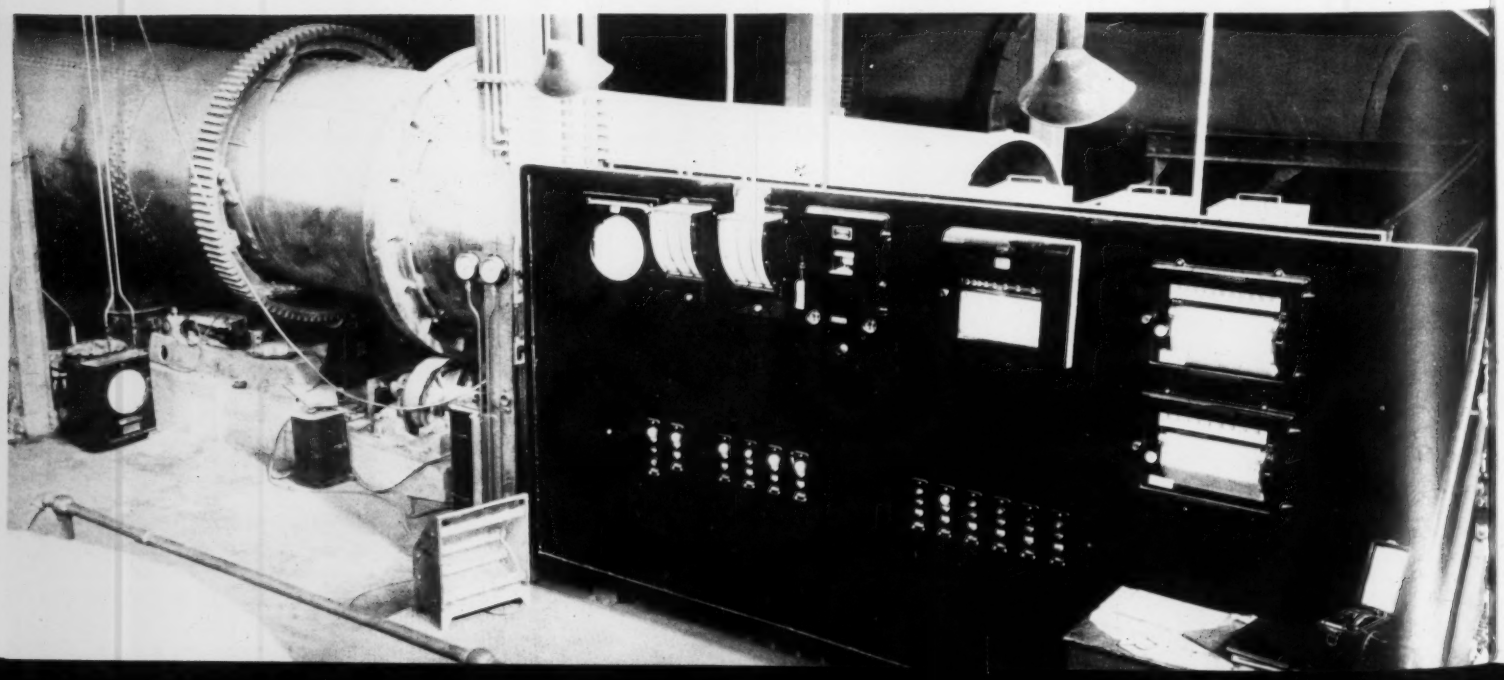
If, due to irregular operating conditions, the control instruments cannot maintain the set conditions, the operators remove or add sprays to the hydrator chamber so that the instruments can maintain their control of the temperature. By this method we have found it possible to control accurately the temperature of the gas leaving the hydrator and at the same time maintain proper acid strength.

Thermocouple Tubes

All thermocouples are installed in porcelain protection tubes, usually Mullite. In places exposed to high-temperature P_2O_5 these tubes are inserted in a well made of a Zircon tile, Zircon being the only material known which will withstand the hot P_2O_5 fumes. This heavy well undoubtedly produces a considerable lag, but it is unavoidable if temperatures are to be measured at all in these places.

Where low-temperature gas is involved after hydration, bronze, brass, and stainless steel wells have been found satisfactory in various locations, the correct alloy for each point being obtained by experiment.

Control Board on Rock Phosphate Fusion Furnace.



CARE OF INSTRUMENTS

Department maintains an instrument laboratory under direction of an assistant electrical engineer who, with assistants, installs all instruments and maintains instrument inspection service. All instruments in the operating plant are inspected daily. Potentiometers are checked against the standard cell, flow meters and pressure gages checked for zero setting and with a manometer if for any reason their accuracy is suspected. Electrical instruments are provided with test blocks and are standardized as often as necessary, usually about once every three months. The instruments found to be out of adjustment are either adjusted by the inspector on the spot or, if repairs are necessary, a temporary instrument is installed and the defective instrument returned to the laboratory for repairs.

Research on special instruments and control devices is also carried on by the Chemical Engineering Research Division in coöperation with the instrument laboratory. An example of such research is the development of a photoelectric cell control which picks out conveyor pans which have red-hot nodules in them and automatically sprays these pans with water.

INSTRUMENT TROUBLES

The biggest trouble experienced with instruments has been the inability to find materials which will consistently withstand the attack of phosphoric acid and hot P_2O_5 fumes. For this reason it is a common occurrence at any time during the 24 hours for thermocouples to burn out, requiring immediate replacement. To care for this the instrument laboratory prepares a number of thermocouples of proper length and type for the various services. These thermocouples, which require only the connection of the lead wires to binding posts, are carefully labeled and set up in a rack on the furnace operating floor. Whenever a thermocouple stops generating emf., the shift electricians remove it and, if burned out, replace it with the proper thermocouple taken from the rack. The old thermocouple head is placed back in the rack and gathered up by the instrument inspector at regular intervals.

Considerable trouble was formerly experienced with ordinary dry cells on potentiometers where automatic standardization was not used, due to the extreme temperature changes present at our switchboards. As stated previously, this matter has been corrected by the use of air cell batteries which appear to be less susceptible to temperature changes, especially heat, than the ordinary dry cell. Pressure gages, draft gages, and certain flow meters are highly susceptible to clogging of the lines due to deposition of foreign material. This trouble has been ended by allowing an extremely small amount of gas, air or liquid, to flow countercurrent from the gages or meters to the pressure point. Such a flow does not impair the accuracy or sensitivity of the meter, if properly proportioned.

LABORATORY INSTRUMENTS

A considerable number of instruments are required for use in the engineering research laboratories. For temperature measurements up to 3000° F. portable Wheatstone bridges and potentiometers are used in connection with appropriate thermocouples; for the higher temperatures optical or radiation pyrometers are used. Draft gages are usually of the inclined type, or, if a record is desired, the diaphragm type. If the temperatures are to be recorded, a recording potentiometer is used and the laboratory maintains a stock of slidewire bridges and charts for a number of the ranges commonly used. Instruments are issued to the project engineers who, at the completion of their project, return them to the laboratory where they are carefully checked and standardized and put back in stock for future use.

INSTRUMENT LABORATORY

The instrument laboratory is provided with a sensitive lathe and a drill press, together with small tools for the manufacture of small parts and equipment. A high-precision potentiometer is kept for laboratory checking of thermocouples and potentiometers, and a carefully-standardized optical pyrometer for checking optical pyrometers. Both radiation and optical pyrometers are checked by sighting them on a refractory block placed in the tube in a Globar muffle furnace, the temperature of which is checked by a platinum *vs.* platinum – 10% rhodium thermocouple and the laboratory potentiometer. This furnace is also used to standardize thermocouples.

Combustion Chamber Roof, showing Zircon Thermocouple Wells

Standard electrical instruments: ammeters, voltmeters, wattmeters, and a rotating standard watthour meter, are kept by the laboratory for the testing of electrical instruments. Radiation and optical pyrometers which are in daily use and portable potentiometers which are to be in use for long periods of time, are checked at regular intervals, usually once a week, by comparing them with an instrument previously checked in the laboratory. If they are found to be inaccurate the laboratory instrument is temporarily substituted for the inaccurate instrument which is returned to the laboratory, properly adjusted, and then taken back to the job.

It has been the Authority's experience that to have plant instrument men available at all times has well repaid them by keeping the instruments adjusted and by maintaining the confidence of the operators in the accuracy of the instruments which they are using.

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A Method of Measuring Peak Pressures Developed Due to Water-Hammer

By E. H. SALTER

Engineer, Electrical Testing Laboratories, New York City

TWO methods have been used for the determination of the peak pressures encountered in the water-hammer following the rapid closing of a valve in a water line. These methods are (a) the engine indicator and (b) the ordinary Bourdon tube pressure gage equipped with a maximum-registering hand. In an investigation of water-hammer conditions in domestic water supply systems made at Electrical Testing Laboratories attempts were made to check these methods one against the other. The result was far from satisfactory.

In the case of the gages it was found that the position taken by the maximum hand depended upon the inertia of the hand, the friction offered by the mounting and just how the blow from the operating mechanism was delivered. Various attempts were made to adjust gages to agree with the maximum pressure indicated by the engine indicator, but although methods of adjustment were found which gave the desired agreement initially, the gages would not maintain their calibration.

During the process of making these checks between the engine indicator and the gages, it was noted that the maximum pressure shown by the indicator under a definite condition was apparently affected by the stiffness of the indicator spring used. When a light spring was used the hammer pressures found were lower than when a heavier spring was used. This was apparently due to the relief of the pressure afforded by the movement of the indicator piston in recording the pressures, even though that movement at most is small. Such a finding, of course, meant that the true maximum instantaneous pressure in a given pipe system could never be determined by the engine indicator, since some pressure-relief is always afforded by the movement of the piston in making the record.

As a result of these findings, a simple arrangement was devised, meeting all the requirements for a true peak pressure determination, and demanding only that the hammer pressure be repeated several times. This device consists of an ordinary Bourdon tube pressure gage, filled with [illegible] and connected into the system, at the point where measurement is desired, through a small spring-loaded check valve. The accompanying photograph shows such a peak pressure gage made using a ¼" extra-heavy vertical check valve and a 300-lb. pressure gage.

As long as the sum of the water pressure and spring pressure on the gage side of the check valve is below the peak pressure in the water system, each pressure rise will admit water to the gage and to some extent be relieved. However, as the forces on the two sides of the check valve approach equality, less and less relief is afforded, until finally, when there is no further flow of water into the gage, the summation of the gage reading and the spring pressure is the true peak water pressure. It was found that the water-hammer had to be repeated from two to six times to properly show the peak pressure, the number of repetitions depending upon how much air remained in the gage.

This type of peak pressure indicator was then checked against the engine indicator. When the two were connected closely enough for the pressure relief afforded by the indicator to be effective at the gage, the two methods were found to be in agreement. This peak pressure gage method was then successfully used on household water systems in which the maximum instantaneous water pressures indicated due to water-hammer were of the order of 1000 lbs. in.^{2}.

When such a gage is well made, the "drooping" of the hand, due to leakage in joints and at the check valve, is slow. For investigations in which numerous pressure measurements are to be made it then becomes necessary to provide a valve on the gage side of the check valve for the purpose of releasing the pressure and resetting the gage to a low pressure indication. The photograph shows a needle valve in position for this purpose.

DANGERS—*Continued from page 147*

machinery seem to fear also the political and economic and social structure which we have inherited from the Founding Fathers of this Republic. Engineers should hold fast with every ounce of their strength to the conviction that their work is a blessing. Mr. Yates no doubt has too lofty a character to slip over the political fence, but thousands of youths who begin by losing faith in the benefits of automaticity might end up by losing faith in all articles of the American Credo. Even Mr. Yates makes use in his book of the expression "creaky economic system" and writes us: "Ostrich-like, you ignore the fact [machines causing social maladjustments] and, ostrich-like, you will keep on ignoring the fact *until the whole social order comes tumbling down.*" (Italics ours.) We hold that American inventiveness and enterprise have *built* our social order; that they will continue to do so, and that labor-saving methods constitute an essential phase of this process of social and economic *betterment*—a strong pillar *preventing* "tumbling down."

Errata in article on "Relations Involved in Metering Rate of Flow" in April issue:

Page 117, fourth line from bottom, the expression "[illegible] *op.cit.*" should occur once only. Page 122, second line of Item 1 in caption of figure, the comma should be a decimal point. Page 124, fourth paragraph, thirteenth line, the first "the" should be stricken out.

nstrumentation in the Soap Industry

By C. T. ATWOOD
Lever Brothers Co., Cambridge, Mass.

IN considering the applications of instruments in the Soap Industry it should be understood that a good percentage of operations in the industry are still largely of batch nature. In these processes final control is usually exercised by the chemist's burette and test tube, rather than by pressure gages, temperature recorders, and so forth. In those processes of a more nearly continuous type, however, instrumentation is of great importance although manual rather than automatic control remains the rule. For the sake of clarity, we propose to follow the normal continuity of operations in discussing this topic.

Oil Handling

Oils, fats, and caustic soda, the principal raw materials in soap manufacture, are received in tank cars (drums for the smaller concerns) and weighed in on track scales. To obtain a representative sample from a car of oil or fat, an instrument called a sampling-thief is employed. This consists of a 2" aluminum tube 12' long, with a valve at the bottom, operated by a ¼" steel rod attached to the side of the tube and running its entire length. In operation, the thief, with valve open, is inserted into the manhole of the tank car and lowered slowly into the oil or melted fat. When it strikes bottom, the rod is allowed to drop, closing the valve and securing the sample. The filled sampler is removed from the car and is drained into a pail where the oil is thoroughly mixed before analysis.

Closed steam coils within the cars are used to melt out the solid fats to a pumpable consistency. Temperature control is not necessary at this point, but steam pressure regulation is required.

From the cars the melted oil is pumped to either a warm tank storage room or to outside storage tanks. The tank room air temperature is thermostatically held at 120° F., to maintain the fats in a liquid pumpable condition.

The quantity of oil in the tanks is best determined by tape measurement or by float gages where the tanks are so equipped. Pneumercators and Telegages have been tried for measuring liquid fats and oils, but these become insufficiently accurate in continuous use unless subjected to frequent overhaul. The discrepancies between actual measurements and figures shown by these pneumatic gages are caused by the accumulation of solid material (fat or foreign matter) within the apparatus. Before pumping to the refining and bleaching equipment or to the soap kettles the liquid oil is weighed in large tank scales equipped with a ticket recording feature so that a printed record of each transfer is obtained.

Caustic soda refining is done at definite temperatures, recording thermometers being used for best results. Lye strengths are adjusted by using Baumé hydrometers. Laboratory analyses establish quantities.

Vacuum bleaching is used on some tallows when special bleaching efficiency is required. Vacuum gages and recording thermometers of the usual types are used, but laboratory color readings must determine the characteristics and duration of the bleach.

Earth bleaching is most effective at certain temperatures, but excessive heat causes oxidation and color reversion. Recording thermometers are essential. Laboratory color readings determine the bleach necessary.

After the refining and bleaching steps, the oils are filter-pressed. Hydraulic closing devices are frequently employed and these are equipped with pressure gages to indicate the tightness of the plates. Pressure gages on the feed lines help materially to prevent breakage of the cloths and leakage, and indicate the degree to which the press is filled. During pumping from the bleached oil storage tanks to the soap kettles, the quantity of oil is measured in the tanks by float gages.

Soap Boiling

In the soap kettles, heat and agitation are provided by means of open and closed steam coils, resulting in a temperature slightly over 212° F. Steam gages are necessary on the mains to indicate available pressures. Compressed air is also occasionally supplied for agitation; pressure gages show supply.

Liquid caustic soda is drawn from a circulating system when required. The caustic storage tanks are maintained at constant temperature by means of thermostatic controls. A pressure regulator in the circulating system compensates for changes in pressure due to varying rates of consumption of the caustic. The caustic storage tanks can be equipped with overflow lines which include bell or light indicators that denote the passing of liquid.

To reduce the escape of steam and the resultant condensation of moisture in the soap kettle rooms, some of the kettles have been equipped with covers and hoods of various types. Since observation is somewhat restricted by these covers, the kettles are equipped with automatic lights and bells actuated by thermocouples to indicate the rise of boiling soap in the kettle.

Soap boiling must still be classed as an art, and the soapmakers' principal instruments are eyes, fingers, tongue, and trowel. Great store is placed on the appearance and feel of a kettle of soap at any given stage. An experienced soap boiler can judge free alkali percentages, in the lower ranges, with surprising accuracy by means of the taste, although it usually is rather rough treatment for the tongue. The trowel (an ordinary mason's trowel) is invaluable at the finish of a boil of settled soap. The hot soap must run off the trowel "just so" before it can be left to settle, else an improper nigre separation will result. Perhaps the trowel will ultimately be replaced by a simple centrifugal separator which will prove more accurate, just as taste is being replaced to a large extent by laboratory analysis. Flowmeters for the caustic and oil may ultimately prove of considerable assistance during saponification.

To obtain soap and lye samples for the laboratory, a device called a "go-devil" is used: it consists of a hollow cast-iron cylinder 3" in diameter and 10" high. At the open end of the cylinder are attached a handle and chain for lowering the sampler into a kettle of molten soap.

No soap can pass to the next operation without laboratory approval, although rough chemical tests for free alkali are made on the spot by the soap boilers.

From the kettles the settled soap is pumped to thermostatically controlled storage tanks which maintain the soap in a uniform liquid condition. Indicating thermometers are provided for convenient reading. The quantity of soap in each tank is shown by pneumatic indicators which operate on the principle of static pressure. Although these mechanical instruments were not found sufficiently accurate for oil measurements, they are used for soap because the indicators can be located at a distance from the tanks, at points where frequent readings are necessary.

Glycerin Recovery

Glycerin-containing lyes move from the soap kettles to storage, then through scale tanks to treatment tanks in the Glycerin Department. A satisfactory flowmeter would eliminate the scale tanks and contribute to continuous operation.

In lye treatment the free alkali is neutralized with hydrochloric acid under laboratory control. Alum is weighed out and added to the lye to precipitate fatty acids as insoluble soaps. After filtration the treated lye is transferred to the vacuum evaporators where it is concentrated. This equipment is supplied with vacuum indicators and recorders, steam pressure gages and recording thermometers.

Steam reducing valves are used to maintain uniform steam pressure. Control devices are used to some extent for maintaining constant liquid level in the evaporators.

In the distillation of glycerin, a considerable number of control instruments are used. These consist of recording and indicating vacuum gages, recording and indicating thermometers and pressure gages on all distilling units and on the condensing equipment. Temperature and pressure controllers are utilized for condensing the various fractions of glycerin vapors within the proven limits.

A recording barometer is installed in the Glycerin Department for frequent comparison with the manometers on the various pieces of vacuum equipment. Control of the distilled glycerin is governed by the instruments just described, and by frequent laboratory checks made to insure quality.

The distilled glycerin is bleached and filtered through the usual type filter press. These presses are equipped with temperature and pressure indicators to assist in filtration.

The finished glycerin is taken from storage in tank cars or 100-gallon drums, weighing being done on track scales in the first instance and platform scales in the second.

The liquid chemicals consumed in the glycerin recovery processes are received in tank trucks and are weighed on a truck scale before being pumped to storage. The mineral acid is transferred within the department by means of an acid egg and is measured volumetrically in calibrated tanks.

Chip Dryers

From the storage tanks the molten soap is fed to continuous chip dryers. Temperature recorders and controllers are installed on all dryers. Temperature indicators show inlet and outlet figures for cooling water in the chill rolls. These latter temperatures must be varied according to the type of soap as well as atmospheric conditions. Most continuous dryers are equipped with regulating valves designed to maintain uniform chip moistures by preserving constant moisture removal conditions as far as possible.

Micrometers are necessary in determining chip thickness and thicknesses variations at numerous discharge points.

Humidity recorders and controllers have been tried experimentally with continuous soap dryers, but without proving their value. One great handicap in such an installation is the difficulty in preventing the wet-bulb thermometer from becoming coated with soap dust and thus losing its sensitivity. In view of the success of humidity-controlling apparatus in other industries, however, it is not unlikely that this problem will ultimately be solved.

As the chips leave the drying chamber, it is important that they have a uniform moisture content. At present, however, we are not equipped with a means of immediately and accurately determining the moisture of the sampled chips. Electrical conductivity has not shown great accuracy with soap because of the poor conductivity of the soap itself and the varying electrolyte content. When an electrical moisture tester capable of speedy and accurate determinations on soap is developed, however, a ready market will be found.

Milling

The dried soap chips are conveyed from the dryers to temporary storage bins and from these bins the chips fall into scale hoppers or horizontal mixers supported on scales. Liquid ingredients such as perfume are frequently weighed on automatic scales equipped with a photocell which interrupts the flow when proper weight is reached. The duration of mixing operations is regulated by electric timing clocks. Upon leaving the mixers, the soap passes through banks of water-cooled steel mills. The water leaving the mills is tested by indicating thermometers, since the mill temperature has a direct bearing on soap output as well as on quality.

In the milling of soap flakes for package sale, the cooling water temperature must be properly regulated. This is accomplished with the aid of indicating thermometers.

Plodding

In the plodding operation the ribbons of soap are amalgamated into a homogeneous mass which is extruded continuously through a heated die. Most plodders are equipped with two jackets, one on the barrel and one on the tapered nose, with thermometers to show the water inlet and o temperatures of each.

Plodded bar soap may be coded so that the manufactu can tell the date of production of any given sample. T coding is done at any of a number of locations with ma type similar to that used in printing. In some cases coding is done by a revolving metal cylinder which ho the type and as it revolves imprints the code at interv on the strip of extruded soap. In another case one or m letters are inserted in the stamping die. In yet anoth instance a moving finger codes the stamped bar on o edge just prior to wrapping.

Packing

After wrapping and packing it is customary to stamp code on the case and this is done by hand stamp or rotatin cylinder to provide for identification of the product.

Cases of soap on conveyors from the packing room to the warehouse actuate mechanical or photoelectric counters of conventional type. To prevent the formation of serious jams, electric trippers which actuate lights or horns, or switch off the power, are installed at various points in the conveying system.

Spray Drying

In preparing a mixture to be sprayed it is necessary to measure the liquid soap from the storage tank by means of a scale tank before transferring to the crutcher. Sodium silicate, a common ingredient in soap powder, is also weighed from the silicate storage tank by means of a scale tank. In the storage tank the temperature is maintained at a suitable level by thermostatic control. In the crutcher, which may be either open or closed, the ingredients are thoroughly mixed and brought to the proper temperature. The slurry is then pumped to the spray nozzles, often *via* an intermediate storage reservoir to insure continuous operation. Additional heat is imparted to the mix by means of steam coils or jackets, oil heaters, loop heaters, etc., according to the demands of the process. Pumping is usually accomplished by a rotary pump to avoid pressure fluctuation at the nozzles.

The soap pressure at point of spraying may be recorded; the atomizing steam or air pressure is usually recorded also on conventional equipment.

In installations using hot air it is customary to record the inlet temperature of the heated air. When gas furnaces are used to boost the temperature above that obtainable from high-pressure steam, it is necessary to employ gas pressure gages, hot-air temperature recorders and automatic controllers, and automatic thermocouples to relight the gas and set off an alarm in case of pressure drop. Fuel oil is often used instead of gas.

The fans for handling the high-temperature air have water-cooled bearings to prevent overheating. In some cases these fans are turbine-driven and tachometers indicate the speed of rotation.

Most successful spray-drying units include exhaust fans in addition to the intake fans and in some cases these operate under slight negative pressure. When this is the case, indicating and recording draft gages may be supplied to insure the proper conditions.

Boiler House

Due to the quantities of process steam consumed, soap factories are usually provided with large boiler houses. The usual steam flowmeter and CO_2 indicator are installed on each boiler with indicating draft gages for furnace, flue, and air box. Temperature recorders indicate the flue gas temperatures to and from the economizers. Steam pressure gages are used with each boiler with a master pressure gage on the manifold.

Compressed air is generated by steam and electrical systems which include the use of pressure and load control gages. Turbine equipment for generating power is supplied with a recording watt-meter and a synchroscope to tie in with the power drawn from the city lines. Coal is weighed in the cars and in batches from the storage bin. Water fed to the boilers is from a surge tank equipped with a float

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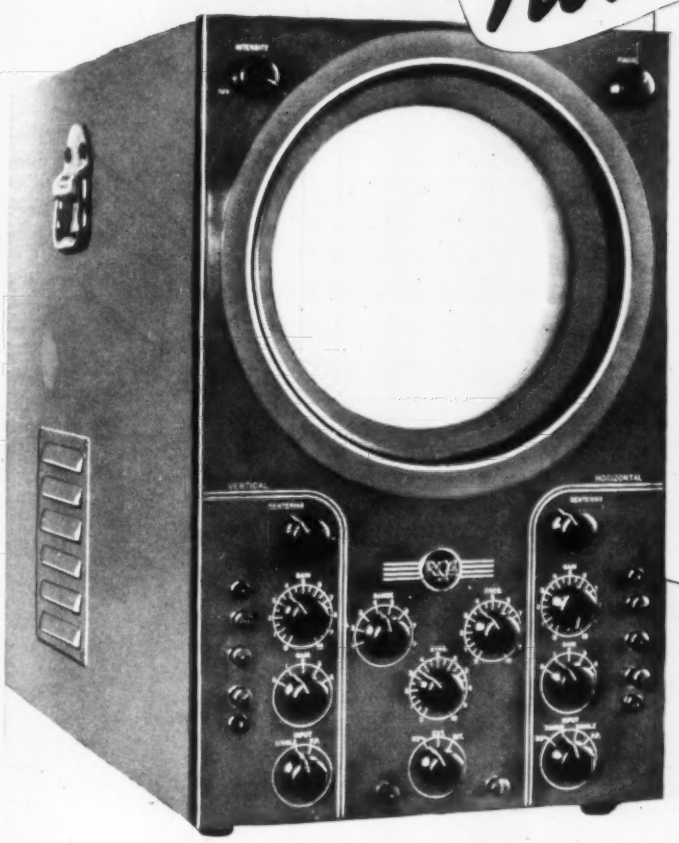

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OPERATING CHARACTERISTICS

Maximum deflection sensitivity	
no amplification	20 volts R.M.S. per inch
with amplification	0.02 volts R.M.S. per inch
Amplifier input impedance	
push-pull	1 megohm at 1000 cycles
single	0.5 megohm at 1000 cycles
Maximum D.C. insulation	250 volts
Timing axis frequency range	4-18,000 cycles
Amplifier frequency response	4-100,000 cycles
Cathode Ray Tube	9" electrostatic deflection

POWER REQUIREMENTS

Voltage	110-120 volts
Frequency	50-60 cycles
Power	150 watts
Fuse protection	5amps

PHYSICAL SPECIFICATIONS

Weight	100 pounds
Width	12 inches
Depth	25 inches
Height	20 inches

TUBES

1 RCA-914 High Vacuum Electrostatic
1 RCA-874 1 RCA-879 1 RCA-885
1 RCA-5Z3 8 RCA-6C6 2 RCA-6J7
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